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ETI
ELECTRONICS TODAY INTERNATIONAL

ELECTRONICS, COMPUTERS, TECHNOLOGY

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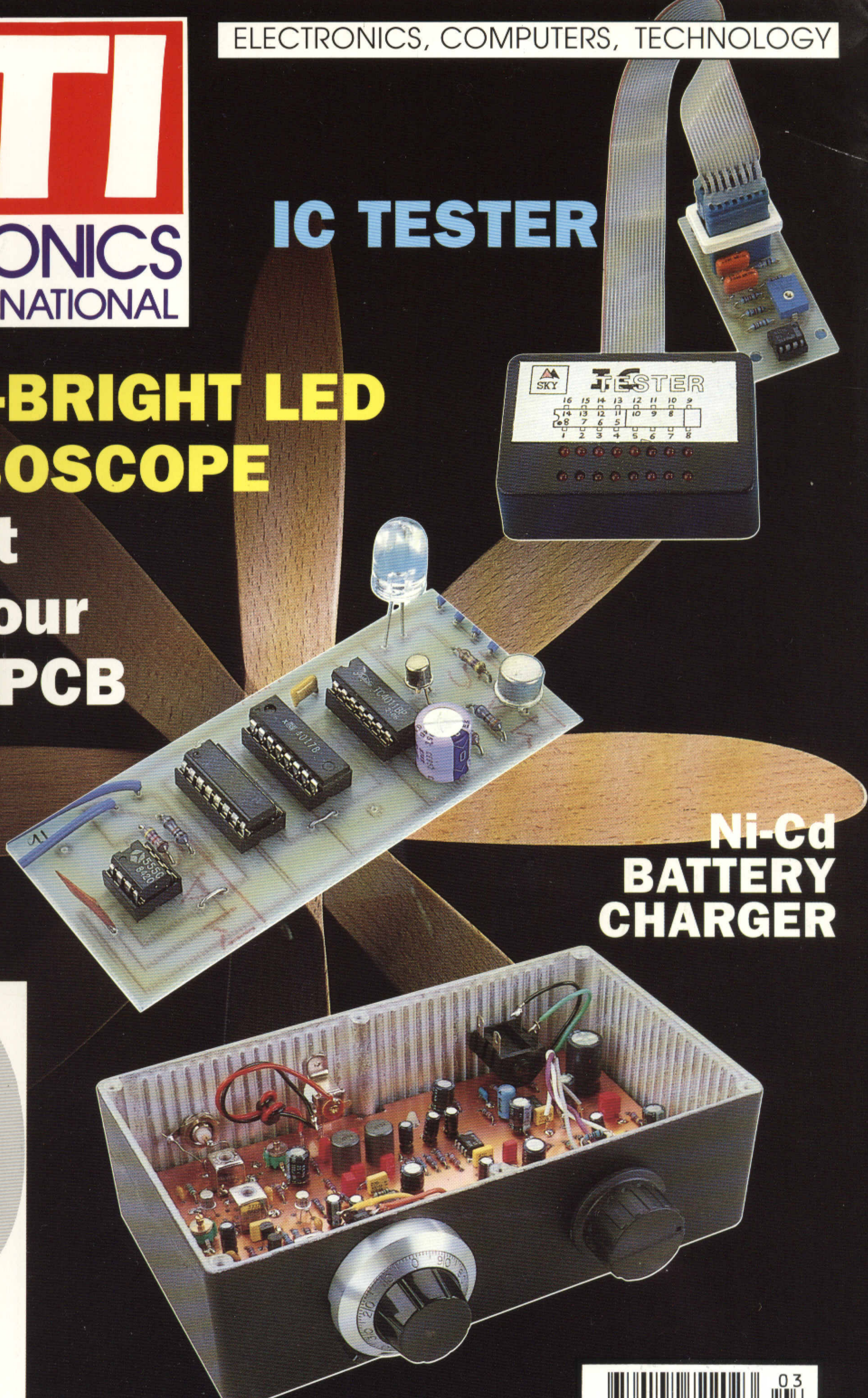

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March 1993

Features & Projects

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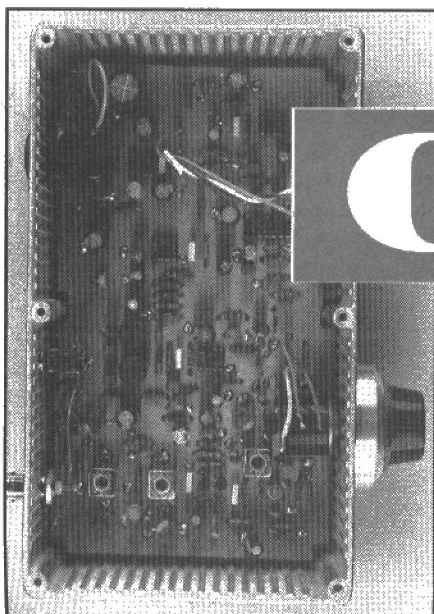
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Regulars

Editorial

by Paul Freeman

Evesdropping is back in fashion - and I don't mean listening at the door or viewing spy satellite data, for these could be argued, are regular features of current life. No, it's the roombugs or phone taps imposed upon those carringing out very public roles, who are subject to the latest media scrutiny.

The insatiable demand for finding out secrets about others without them knowing has grown thanks to the help given by an increased electronics capability and availability. For an electronic surveillance business, marketing their latest gadgets, the time has never been better.

The latest reasons for intrusion into private lives is not so much about exposing criminal activity, but revealing interpersonal behaviour for the sake of a 'fast buck'.

It might help, if those closely followed by the media, communicate using a message scrambling technique when they use a telecoms network be it by wire or by radio on the cellnet system. As we know, a conversation transmitted electromagnetically can easily be received using a 'scanner' radio.

However, could these lax arrangements form the basis for an official leak? We might never know.

ETI has experienced this interest in surveillance after running a series on the subject way back in 1989. It seems there is an extra sense of satisfaction to not only listening-in but knowing the bug was created with your own hands.

OPEN CHANNEL

It takes a computer to know a computer. Many computer users know the problem - getting their machine to talk to someone else's is fraught with difficulties. Unless both machines are connected properly and both are running the right software, chances are they'll not communicate at all.

Of course, you can buy a proper network, cables and software and so on so all computers in an office, say, are plugged into the local area network. Usually there's a file server comprising a dedicated computer and high-capacity hard disk drive through which all the rest pass their communications. Each distributed computer then has access to the hard disk drive for storage of data, applications and files.

The only problem with this is that the software to do it, running on each computer in the network, needs RAM to run. If you've a computer with only limited RAM (say, you have only the DOS limit of 640 Kbyte) then it's possible the network software takes up just sufficient of your RAM to prevent your usual applications from running.

There are moves afoot - Windows for Workgroups, for example - which hope to get over this using the extended memory which Windows can access. In such a case, the network is usually described these days as a peer-to-peer network as no particular server is used.

Ironically, Windows users might like to think the idea is new, but it's not. Apple Macintosh computers have been able to do it for eight years, with their in-built LocalTalk network hardware and AppleTalk software. What's more a Mac network's easier to setup (plug a lead into a serial port of each computer) and use (allocating a file or folder for the network).

Ironically again, it's just a pity it takes the add-on extra of something like Windows to draw most people's attention first to a graphical user interface and from thence to the Mac's inherent abilities.

Learn Your Lesson

Acorn Computers, the manufacturer of (among others) the BBC range of computers is looking to future generations of school computers. Acorn sees the child in tomorrow's schools as having a computer of its own. Such a one-per-child machine will be hand-held and provide the power at least of existing 486-based desktop personal computers (or Macintosh II machines).

The machine will be inexpensive (it will need to be), and function around the 32-bit reduced instruction set computer (RISC) microprocessor I've mentioned before in Open Channel, the ARM 600 series. This chip is developed and made by Advanced RISC Machines of Cambridge, a company jointly owned and funded by Acorn and Apple Computers.

Acorn's one-per-child project forms part of the POWER project which, in turn, is part of the ESPRIT III (POWER stands for Portable Workstation for Education in Europe; ESPRIT stands for European Strategic Program for Research in Information Technology - learn this by Friday, I'll be testing you then) program, which has the aim of increasing the general competitiveness of European industries in information technology areas.

To achieve the aim, the POWER project brings together a wide range of European companies which are all leaders in their own fields. Acorn hopes the one-per-child computer will be available in about three years time and will cost no more than around £250.

Let Dead Dogs Lie

Two things happened yesterday (I'm writing this around the middle of December) which I feel I'm obliged to mention. They're both examples of what I consider to be bad planning and lack of commitment to projects.

First, last night I noticed the NICAM icon on my stereo television had finally lit up on the two BBC channels. I live in the Midlands and receive broadcasts from the Waltham transmitter which, if I've got my geography right, is somewhere in Lincolnshire. We've had NICAM stereo broadcasts on the independent channels for a while now, but the BBC has always seemed to resist the notion of upgrading its transmitter because I guess the extra population coverage didn't really warrant the expense. Finally, however, it's done and we've got our better BBC sound. I might add that this has finally occurred some three years after the programme to provide national coverage started.

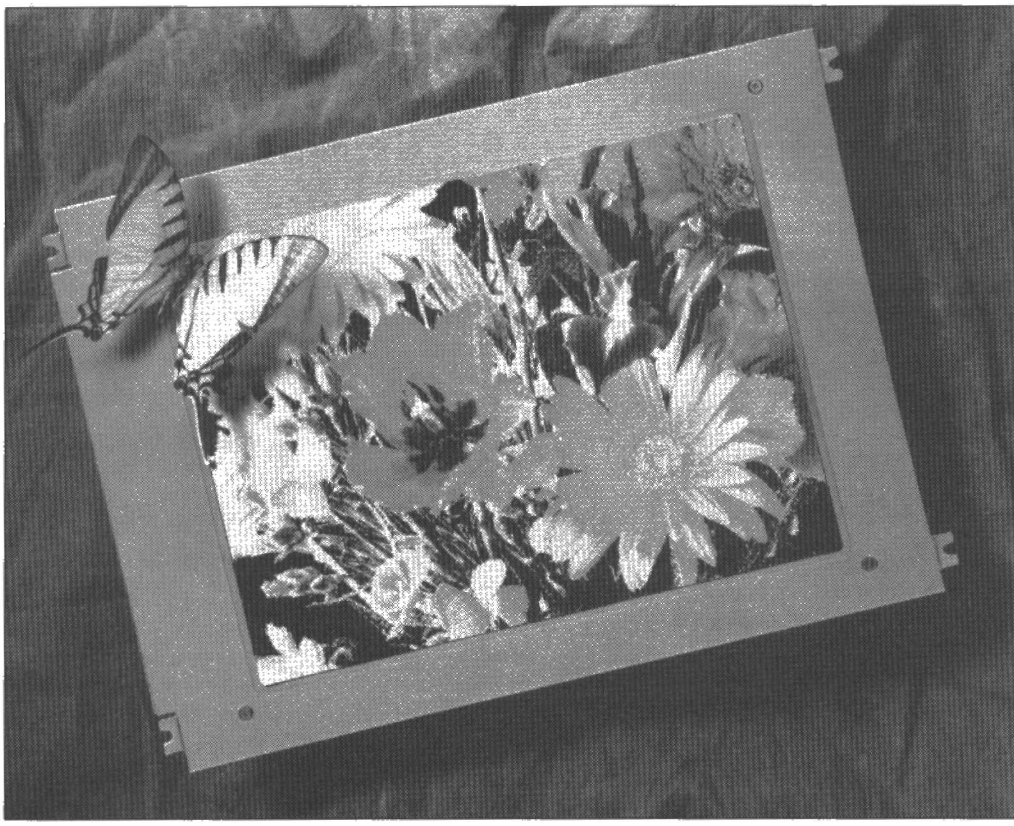
There are still areas of the country uncovered by NICAM sound transmission, despite the BBC being incidental in developing the system in the first place, and despite the original concept being seen as a satellite TV killer. Satellite TV, on the contrary however, is now very much not killed and in fact getting stronger by the day. Maybe rapid and complete national coverage of NICAM would have prevented many people buying satellite TV systems, maybe not. Who knows? Maybe also most people don't care. But one thing's for sure - there's no point in developing a system to do a job then not investing enough money in it to do the job quickly and efficiently. You might as well not do the job at all.

The other thing which happened yesterday (well, OK, on the 18 December if you must know the exact date) was the Independent Television Commission's refusal to grant a licence to Channel 5 Holding's application to run the proposed new terrestrial television channel.

I've no criticism here of the ITC. After all, they're in the best position to know if an applicant has the wherewithall and the financial backing to run a new national television service. They've no axes to grind, they want to do what's best.

No, my criticism goes deeper than that and stems from a more basic question. Why, if there's no organisation which is prepared or able to put together a decent proposal to run a new national television service, was the idea of the service raised in the first place? I'm sure anyone would be justified in thinking the whole thing rather a waste of time, money and manpower. I know I do, and unless the situation is reviewed and the service made more attractive to prospective operators the people who dreamed up the idea in the first place (the Government) should just as sloppily put it down again.

Keith Brindley



LOW POWER COLOUR LCD PANEL

Now available from Anders Electronics is the new Sanyo VGA colour LCD panel. With its low-power circuitry, the Sanyo LCD provides a high quality backlit 256-colour display and requires just 5W power supply, including the cold-cathode fluorescent backlight.

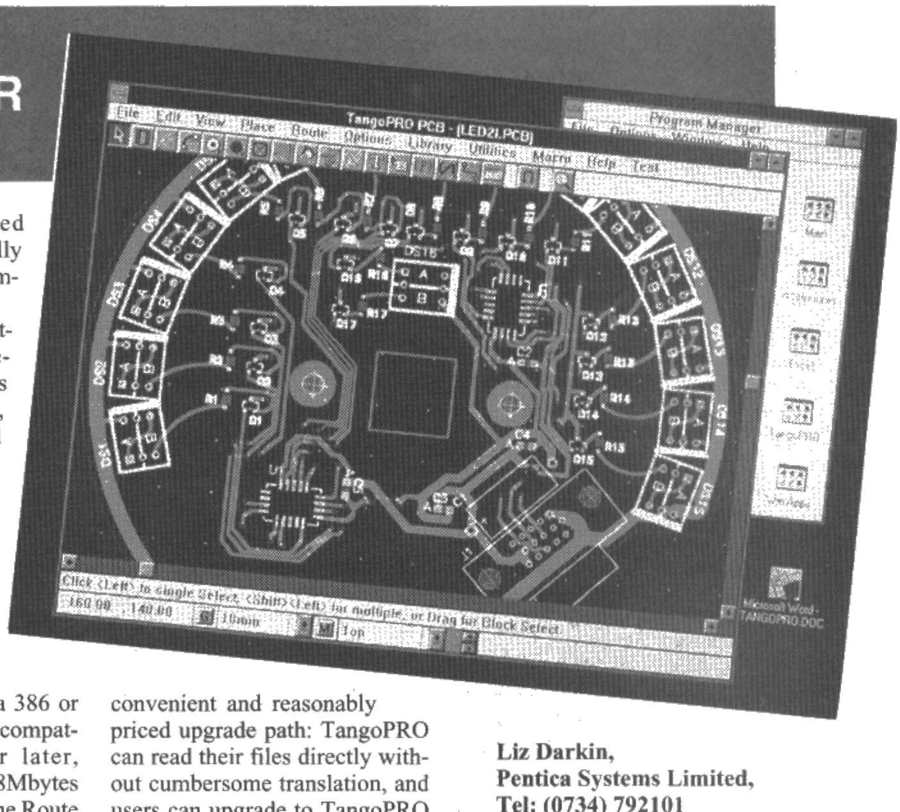
The compact panel is 8.5mm thick, ideal for building into miniature, lightweight, portable equipment. The display has a fast response to eliminate 'ghosting' and enable the use of a mouse.

Pixel format is 640 x 400 (VGA).

The Sanyo LCD has wide ranging applications including EPOS terminals and banking equipment, telecommunications and industrial control. For further information contact:

Lynn McGoohan,
Anders Electronics Limited,
Tel: 071-388 7171
Fax: 071-387 2951

NEW PCB DESIGN SOFTWARE RUNS UNDER WINDOWS



Pentica Systems has introduced the TangoPRO series of IBM PC compatible electronic design automation (EDA) software. TangoPRO is an entirely new range of printed circuit board design tools, bringing workstation-style performance and ease of use to PC compatible EPA tools.

With a 32-bit architecture, running under Microsoft Windows 3.1, TangoPRO is aimed at professional PCB designers. Advanced features for enhanced productivity include a sub-micron database, copper pour, curved tracks, one tenth-degree rotation, true metric support, and an optional rip-up and reconstruct auto-router.

The integrated TangoPRO suite consists of an advanced PCB layout tool, an optional fast, high-completion auto-router, and the Library Manager which integrates libraries of schematic and component data. Support of up to 16Mbytes of extended memory allows a virtually unlimited number of components per design.

TangoPRO imports netlists from popular schematic capture programs such as TangoSchematic, OrCAD, Schema and ViewLogic.

Available as an option to TangoPRO PCB is TangoPRO Route, a 32-bit auto-router with a unique 'rip-up and reconstruct' algorithm providing fast refresh of complex PCBs.

TangoPRO requires a 386 or 486-based IBM PC or compatible, MS-DOS 5.0 or later, Microsoft Windows 3.1, 8Mbytes of RAM (16Mbytes for the Route option), 10Mbytes hard disk space, and a Microsoft or compatible mouse.

Users of entry-level DOS-based Tango programs will have a convenient and reasonably priced upgrade path: TangoPRO can read their files directly without cumbersome translation, and users can upgrade to TangoPRO with full credit for their earlier programs. For further information contact:

Liz Darkin,
Pentica Systems Limited,
Tel: (0734) 792101
Fax: (0734) 774081

SOLAR-POWERED PLANT TURNER

The new Maplin Plant Turner will support up to 30lbs weight and slowly turn the plant during the day. This will help to promote healthier, well-developed plants, and no more lop-sided plants.

The small solar panel is attached to a 3ft long flying lead, so the cell can be positioned for maximum sunlight. The turntable is 155mm in diameter and has a raised edge, and is finished in two-tone green plastic.

Other possible uses include displays in shop windows or to create an eye-catching display inside cabinets. Bright incandescent light will also operate the Plant Turner.

The price of the Plant Turner is £6.95 (to include VAT).

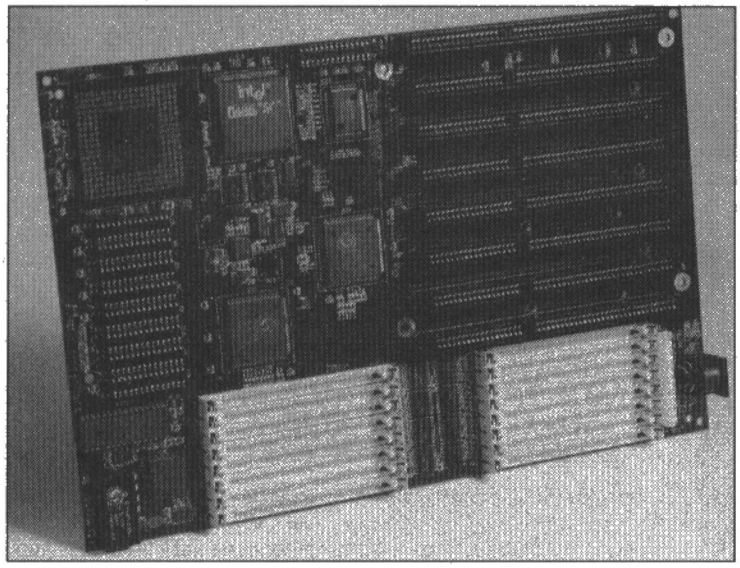
MMIC SWITCHES

A series of low cost GaAs FET TIC switches and attenuators are now stocked by Cirkit. These surface mount devices are particularly suited for cellular phone applications.

The AS002M2-l2 is a single pole, double throw RF switch operating up to 2.5GHz. The switches can be arranged in series for multiple throws and for higher isolation applications. Insertion loss is 0.8dB (max), isolation 35dB (min) and VSWR 1.3:1 (max); each measured at 1GHz. Nominal impedance is 50R and current consumption very low at 50μA (-5V). A low impedance ground for the switch is obtained through three of the eight leads.

Other types in the range include, double pole switches, 4 way switches, attenuators and control FETs.

NEW EURO 486 PC MOTHERBOARD



A British company Array Technology has begun its promised European response to the Far Eastern PC board 'invasion' with the launch of the most flexible, high performance 486 motherboard in the world.

Cheekily called the Taipei, the 80486SX/DX Baby AT motherboard can accept every variant of the Intel 486 chip and allows OEMs the opportunity to carry out upgrades without the need to change components.

While the Taipei is available with 20MHz, 25MHz, 33MHz or 50MHz processors, any eventual upgrade can be achieved through changes to the jumper settings, including the change of clock speeds.

The Taipei Baby AT uses the Symphony SL82C460 chip set and is compatible with both SX and DX versions of the 486 processor, including the low cost PQFP.

At the other end of the scale, the forthcoming P24T is supported using a 238 pin 'overdrive' socket. A board can therefore be supplied with a 486SX processor and no cache, all the way up to 66MHz 486DX2 with 256KBytes cache.

The Taipei uses FLASH EPROM, enabling the end user to upgrade BIOS from floppy disk.

Other features of the motherboard include 16 SIMM sockets in four banks supporting an enlarged memory up to a total of 64MBytes of RAM with a separate cache controller.

Further information is available from the Sales Department, Array Technology, Tel: 0276 691799.

PRINCE RECEIVES SMART BOOK

HRH The Prince of Wales was presented with a fractal 'SmartBook' picture book on a floppy disk by Wirral Metropolitan College at a ceremony in Birkenhead. The SmartBook, documenting work undertaken for The Prince's Trust, was authored by the college using a SmartBook Authoring System.

The SmartBook Authoring System enables authors to combine 100 pages of text with 100 full colour 24-bit photographic pictures into a Smartbook on a single 1.44Mb floppy disk. This is made possible by Iterated Systems' Fractal Transform image compression technology, which achieves compression ratios of up to 100:1 while retaining high levels of image integrity.

The SmartBook Authoring System is £600 plus VAT. Educational discounts are available. Contact Iterated Systems.

GOVERNMENT SPENDING ON SCIENCE AND TECHNOLOGY MUST BE REFOCUSSED, SAYS IEE

Increasing Britain's industrial prosperity should be a principal aim of the forthcoming White Paper on Science and Technology claims the Institution of Electrical Engineers (IEE) in its submission to the Office of Science and Technology.

The IEE response highlights several factors which have contributed to the current weakness of Britain's manufacturing industry, namely: a lack of government support for engineering R&D, particularly in the area of applied specific research; a shortage of 'industry orientated' and innovative professional engineers and a financial climate which discourages innovation and emphasises current year profits rather than future potential.

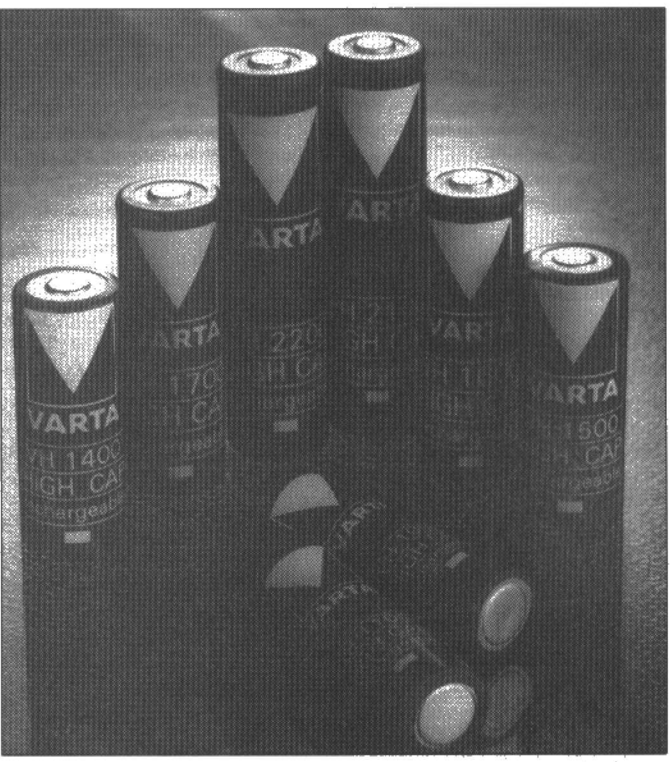
"Whilst science is important" says the IEE "the wealth and well-being of the nation is strongly dependent on its engineering and manufacturing base. The Government must give more support to engineering and technology and create an environment in which the innovation process ranging from basic research, to directed strategic and applied research and specific product development can operate successfully".

"Increasing the resources devoted to basic research will not directly improve the UK's industrial performance" says the IEE response. "Strategic and applied engineering research is the bridge between basic research and product innovation and increased funds need to be focussed on this critical area by re-allocation of resources".

With regard to the current lack of innovation skills the IEE submission recommends a restructuring of postgraduate engineering education to develop commercially oriented and technically competent engineering and industrial managers. It also advocates the setting up of 'Intermediate Institutes' adapted from the German Technical Universities and Fraunhofer Centres. "The Faraday Centres as currently proposed" says the IEE "fall far short of what is required".

In seeking a solution to the current poor UK environment for long term innovation and product development the IEE recommends the introduction of tax incentives such as 150% tax allowances, for qualifying R&D projects on the basis that their success will generate additional Corporation Tax in later years.

NEW NICKEL METAL HYDRIDE BATTERIES



Varta, Europe's largest battery manufacturer, has announced the launch of portable nickel metal hydride (Ni-MH) rechargeable batteries - the 'green', high peformance alternative to Nickel-Cadmium.

Varta's Ni-MH batteries provide over 50% more energy density (Wh/kg) than Nickel Cadmium cells. This makes them ideal for '3-C' applications (computers, portable communications, and consumer electronics) and means that equipment designers can continue the trend of size reduction with increased power supply duration.

Each Varta Ni-MH cell acheives over 500 IEC cycles and has a high drain capability of over 3 CA. They can be fast or trickle charged, and have an in-built protection against overcharge and overdischarge.

Ni-MH batteries have been developed to address environmental concerns about the heavy metal content of nickel cadmium cells. Consequently, the new cells contain 0% lead, 0% mercury and 0.4% cadmium.

CAMBRIDGE PROFESSOR AIMS AT HIGH SPEED TELECOMMS NETWORKS

Bill Crossland, a scientist from BNR Europe, Northern Telecom's R&D subsidiary, has been appointed as Cambridge University's first Research Professor of Photonics. He will take up his duties within the University's Department of Engineering in early November.

The research chair in photonics is funded by Northern Telecom Europe, with additional support from the Newton Trust, and is established to explore new ways in which optics might simplify the architecture of telecommunications transmission networks and switching systems.

Just as electronics is concerned with the movement of electrons, so photonics is concerned with the transmission and control of light (photons); a growing science as the telecommunications industry increasingly uses light frequencies to send digital signals along high capacity optical fibre networks.

At Cambridge, Professor Crossland will spearhead a five-year programme to develop communications architectures using reliable and efficient parallel optical space switching arrays, capable of simultaneous high-speed switching of voice, video, graphics, text and data. Such technology would contribute to the design of complex fibre networks and lead to a dramatic increase in the provision of telecom services to the home; for example, dial-up video, banking and shopping services on demand. The technology will also contribute to ongoing programmes at Cambridge working on three-dimensional images for television and switchable dynamic holograms.

Professor Sir David Williams, Vice-Chancellor, University of Cambridge, says; "We are fortunate indeed in attracting Professor Crossland to this Research Professorship. He is an eminent scientist in his own right, internationally acknowledged for his development of liquid crystals for flat panel television and computer displays. His election further

strengthens the University's position as a world centre for research into fibre based communications systems, as well as supporting our graduate students in this growing area of technology."

Ian Vance, group managing director, BNR Europe Limited adds, "Bill Crossland's appointment is the latest achievement in a long association between our company and the University's Department of Engineering; developed over 20 years through a number of important research collaboratives.

The new chair will help us understand and exploit the power of photonics which is one of the great engineering challenges of today. Professor Crossland's work at Cambridge will not only contribute to Northern Telecom's long term technology understanding but also enhance the company's FiberWorld vision of low cost, high performance, service rich fibre networks."

The Northern Telecom Research Professorship of Photonics will add to Cambridge University's already strong reputation for developing optoelectronic components, recently winning much praise for its work on the design of a cross point switch using a LASER amplifier. Northern Telecom is one of the largest European suppliers of telecommunications equipment and will be providing technical assistance to the new chair through BNR Europe - itself a leading research organisation in optoelectronics.

NEW WIRELESS SECURITY SYSTEM

Every hour more than 70 homes are burgled in the UK - And according to the latest figures just issued from The Home Office the statistics are rising.

Losses from these burglaries cost in excess of £590-million plus all the heartache, inconvenience - and the resulting higher insurance bills.

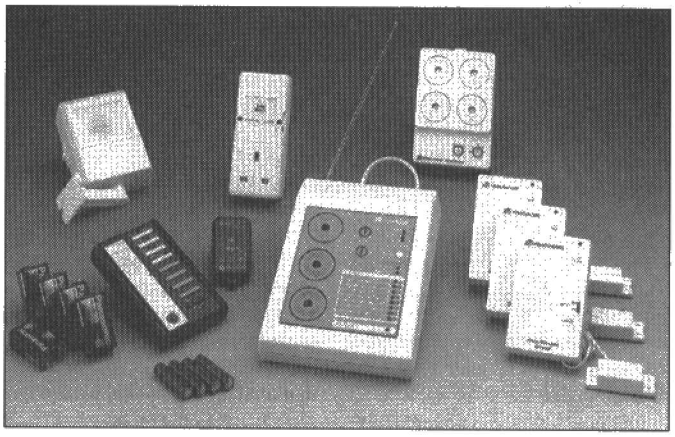
Against this background of rising burglaries comes the launch of the X10 Powerhouse Security System - a completely wireless DTI approved home security system from Celtel Ltd.

Taking less than an hour to install with no additional wiring, the Home Security Kit -SK 8000 - will retail for about £225. It includes base control console (with built-in audio alarm), 2 remote controllers (including one key fob), 3 door/window sensors, a passive infrared movement detector, plus a powerful siren and lamp module.

It operates as follows. The sensor units are battery powered and communicate to a base control station via radio frequency (RF) signals. The sensors are monitored by the base station and faults registered. The base station communicates to an audio alarm and light modules via signals through the existing mains wiring.

The system components are placed where required, their batteries being connected or plugged into the mains and a code button operated to 'register' the units to the base console.

This enables anybody to have an effective security system installed and operating with the minimum of disruption.



Features include an Arm button which is operated after you leave the home and a Disarm button operated by a remote control key fob as you approach the house. Each system can have up to 8 individual controllers to cater for every member of the family.

An additional benefit of the SK8000 Home Security Kit is that it can be used to control the lights too!

Further information from Celtel Ltd, Tel: 0256 64324.

BUILD YOUR OWN PC

The new range of kits from Maplin Electronics provide the opportunity to build your own fully functional, IBM compatible computer with little or no previous experience. All the necessary component modules, cables and instructions are supplied. All the boards are assembled and no soldering is required.

The MAPLIN kits are IBM-AT compatible and use either the 80286 CPU, or the 80386SX. Both these are 100% object code compatible with the 8088 and 8086 microprocessors. All the kits include 1Mb of RAM (expandable to 16Mb), a hard disk, high density floppy drive, extended keyboard and VGA graphics card. The VGA (Video Graphics Array) is compatible with CGA, EGA and Hercules, in mono or in colour, in addition to its own high resolution performance in VGA mode. There are four kits in all, each CPU version is also available with a VGA mono or Super-VGA colour monitor.

The basic specifications for all kits are:

286 16MHz or 386SX or 386SX motherboard with 6 expansion slots; 1Mb of memory; VGA graphics card with 512K RAM (for 800 x 600 resolution, 256 colours); integrated disk controller with I/O card and 2 x serial ports, 1 x parallel and 1 games port; 3.5inch 1.44Mb floppy disk drive (can also read 720K disks); 43Mb, low-profile ID hard disk drive, steel slide-in style desk-top case with 200W power supply, 101/102 key extended keyboard, monitor, MS-DOS 5.0.

Prices are:286PC Mono Kit £505.00 286PC Colour Kit 386PC Mono Kit £540-00 386PC Colour Kit £675-00 (all include VAT)

BINATONE CUTS THE CORD:

If the cordless phone was starting to look outmoded against a newer breed of mobiles, then Binatone has come up with a new cordless to set the record straight and prove that mobility doesn't have to come with a huge price tag.

The new Dialatron ZX2CH will be available in retail outlets from the end of January. At a cost of £79.99 and with Mercury compatibility the new phone will be an inexpensive alternative to the customer who sometimes wants a phone and at other times wants the flexibility of a mobile.

A common complaint of previous cordless phones has been interference on the line; but this time Binatone is one step ahead of the critics. The ZX2CH has a two channel mode which allows the caller to switch to an alternative channel if interference is experienced.

With clarity of calls guaranteed, the owner of the ZX2CH can enjoy the confidence of knowing that the phones' one million combination security code ensures that other cordless users cannot breach the line, but still has a memory to hold nine of those numbers which need to be within easy reach.

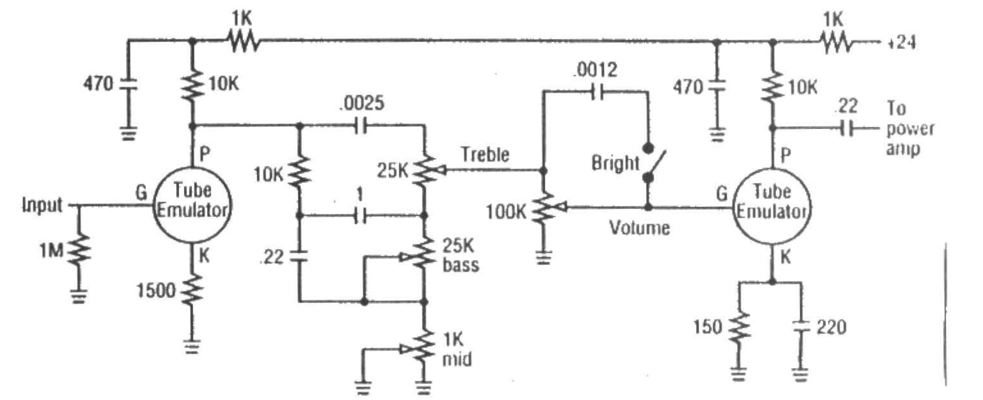
Like its fellow cordless, the Dialatron Relay 200, also has user replaceable batteries, a mute button and line hold facility with melody and a base station which also acts as a telephone.

ETI NEWS

...Stateside...

CLASSIC VACUUM-TUBE SOUND FROM SOLID-STATE DEVICE

This emulator of a Fender reverb preamp provides the aural 'warmth' of tubes



Solid state emulation of vacuum tube

A designer of custom electronic systems, Eric Pritchard, is claiming an achievement that should be music to the audiophile's ears: development of the first successful solid-state emulation of the vacuum tube.

Called the Tube Emulator, it can be designed into classic vacuum-tube audio circuits and, according to the designer, audiophiles who have heard the result say it is indistinguishable from the real thing.

Emulating the vacuum tube may not seem a particularly formidable challenge, but previous attempts to build tube-quality audio systems in solid state have failed.

Pritchard undertook the Tube Emulator project as an offshoot of his business, Metif of Berkeley Springs, which builds custom audio and camera control equipment for the entertainment industry. He concluded that the problem common to all previous approaches was the attempt to emulate an entire audio circuit. Since the vacuum tube is the critical component that distinguishes classical audio systems from modern solid-state versions, Pritchard decided to concentrate on the simpler problem of building a solidstate drop-in replacement for the tube. It took him six years of research to come up with a solid-stage tube equivalent.

"The dynamics of the grid are crucial and turn out to be governed by non-linear differential equations that can only be solved with computers, if at all. Since the tube disappeared from electronics at about the time the computer was invented, exact models of tube dynamics were never developed," Pritchard noted. Engineers thus were compelled to work with a crude linear model of vacuum tube response. 'While the model was adequate for design purposes, it did not address the tube's unique audio qualities.

Pritchard built tube-emulator versions of the classic electric-guitar pre-amp circuits as test beds for his creations. Because he had set out to emulate the tube, rather than a whole circuit, different versions of the emulator could be easily dropped into the circuit.

Confident that his design has passed the ultimate test, Pritchard has founded a company, Deja Vu Audio, to market the Tube Emulator. The circuit is currently realised in a discrete version. The next step will be to work up a hybrid version for electric guitar makers.

New chip

A single-chip array processor demonstrated recently at Bell Communications Research Corp. Inc. performs relational database searches at more than 2 billion results/second. The 40-MHz processor uses a systolic architecture to run an innovative data-partitioning scheme devised by VLSI researchers at the Massachusetts Institute of Technology. The chip can accept a 32-bit data element on every clock cycle.

While the relational approach to organizing large data pools enables users to interact with data in a natural language setting, it also adds a large computational overhead. That burden is turning into a major barrier as the size of databases increases.

The new chip will permit system designers to build dedicated parallel processors that directly implement the relational paradigm.

Predicting non-linear optical interactions

A new theory that predicts strong non-linear optical interactions resulting from optical "pumping" of electrons in materials has been verified in an experiment at the University of Pennsylvania.

Optics experts in the university's department of physics were able to amplify the non-linear properties of diphenylhexatriene (DPH) by a factor of 1,000 simply by illuminating the organic compound with laser light tuned to a specific frequency.

DPH is one of a family of compounds that make an ideal medium for building optical information-processing systems, except that they strongly absorb light in the process.

Since asborption losses result from electrons moving from lower to higher energy levels, the University of Pennsylvania team reasoned that if the electrons were raised to higher energy levels en masse before a signal pulse arrived, the pulse would be able to pass through the material without loss.

By illuminating a sample of DPH with a nanosecond pulse of laser light tuned to the absorption frequency, the researchers discovered that subsequent picosecond pulses passed through without absorption. With absorption effects out of the way, the excited electrons increased the deflection of the test beam by large factors, indicating strong third-order non-linear effects.

If such third-order effects could be harnessed in practical devices, a new range of optical applications would emerge.

Flat panel design

Sandia National Laboratories and Photonics Imaging are developing flatpanel-display manufacturing technology.

The two companies recently signed a cooperative research and development agreement under which they will jointly develop a validated software system that can be applied to flat-panel design and manufacture.

Sandia has expertise in modelling the interaction between materials and plasmas, and it will use that experience to analyze and create various computational models of their operation. Those models will then be used to improve display efficiencies and other parameters of colour plasma display panels.

Photonics produces a variety of flat-panel displays - from just a few centimetres to approximately 1.5 metres in diagonal length.

MORE STATESIDE NEXT MONTH

READ/WRITE ETI Letters

More Power To The Zig-zags

Please give us back our traditional symbols and names - zig-zags for resistors, mhos for conductance, circles for meters. It is much easier to find out and understand than a multitude of rectangles, I do not want to become an ex reader of ETI because the diagrams are so plain and boring.

J Treeby,
Plymouth

I was wondering when somebody would comment on this issue. Many years ago electronic symbols were quite different, particularly between the UK and USA (Do you remember the British Post Office Logic symbols?). Since then there has been a gradual change from our original symbols to American logic symbols (influence of Texas Instruments) in the first instance to the 'box' for the resistor recently. It then makes us realise how influential American products and ideas are even through the Japanese route.

As far as the UK is concerned, it seems we are being pulled by the arms in both directions into the European way of thinking with metrication and the 'Community' from one direction and the all powerful industrial, technological might of the US from the other. It is no wonder we are presently dealing with dual systems in the UK.

Back to the symbols, ETI held on to most of the traditional designs until recently, when Desk Top Publishing took over using many software packages available for drawing.

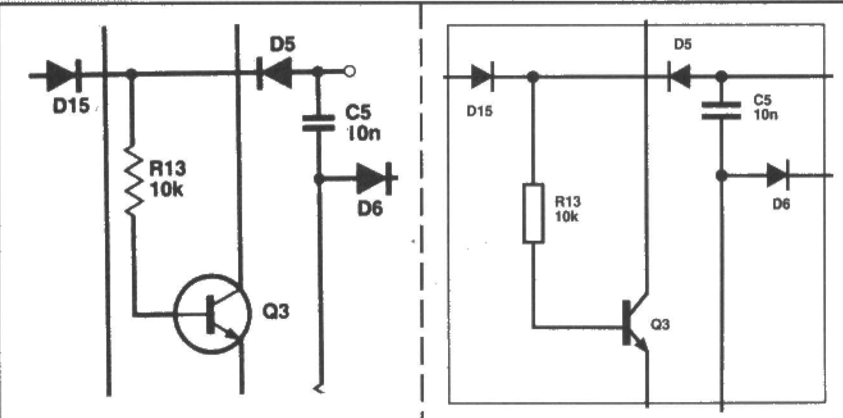
I would like to hear the views of readers to see what the strength of opinion is before being swayed one way or the other. **-Ed.**

AM IF Module required

Many thanks for the publication of my request for information on an audio loop system.

I have a Roberts radio R700 (1966-67) and is of sentimental value. I require an AM IF module for it and I wonder would any reader have an old model that they do not use. The module and the AM oscillator coil are easily removed. Perhaps some of the very old dealers throughout the country may have some old stock, I will pay the cost of postage if not excessive.

Mr P Trayers,
Merseyside
L63 3DX.



Which do you prefer? Old? or New?

Any Moves on the LED Front?

After reading the letter in Read/Write December from Mr Eaton regarding a LED message indicator, I thought I would bring to your notice that in ETI a number of years ago, there was an LED Message Panel project. It included a program and the use of the Sinclair ZX Spectrum. I would therefore suggest your printed circuit firm re-issue the PCB for readers to buy. All you need to do is re-run the article.

I would like to see ETI publish an up-to-date version which can be used by itself or with the Spectrum, BBC micro or Amiga.

Alan Hall,
Glasgow

You are correct, ETI published a project called 'Message Panel' in October-November 1982 and was programmed from the 'ZX' computers. Unfortunately, the PCB is not available for that project anymore (but many others are). Yes we would like to publish an updated version one that includes a greater number of characters on display at any one time, however we are always open to other ideas on the same theme. **- Ed.**

Power at the Right Place and the Right Time

I am an undergraduate at City University studying electrical and electronic engineering and would be most grateful for some information or helpful hints on a project I am working on.

I am currently working in a group that is advising a company, Intermediate Technology (a charity involved in helping underdeveloped countries help themselves), on a project to improve power distribution to remote villagers in Nepal. At present power distribution relies on the villagers acquiring vehicle batteries and shuttling them between recharging points and their homes. Due to the distances involved and the weight of the batteries the villagers tend to leave it to the last minute before recharging. This is leading to seriously reduced battery lives and the villagers having to somehow get more batteries which they cannot easily afford.

We are working on methods of reducing the distances the villagers have to haul the batteries, efficient recharging methods and discharge limiting the batteries. This involves looking into power distribution networks, inverters, basic recharging circuits and very basic discharge limits to be attached to the batteries. Any viable solutions have to be cheap and use components, skills and equipment that are available in Nepal.

Since over the years your wonderful magazine has produced so many varied projects and discussed a wide variety of topics I thought it would be foolish to ignore such a source of technical know-how. I would be most grateful if you send me any useful information hints or references to back copies or books.

Peter Wivall,
Ashord, Middx.

Enough of the flannel! Looking at our projects over the last twenty years, we have presented a variety of battery chargers but nothing on the problems of power distribution in Third world countries.

To minimise battery movement, solar powered recharging would be quite attractive as their is plenty of sunshine. The drawback is the expense at present. Alternative local sources of generation might also be considered temporarily like wind, geothermal and hydro-electric, until cables can be laid. I suggest you find out what the UK electricity generating companies might say about the problem. **- Ed.**

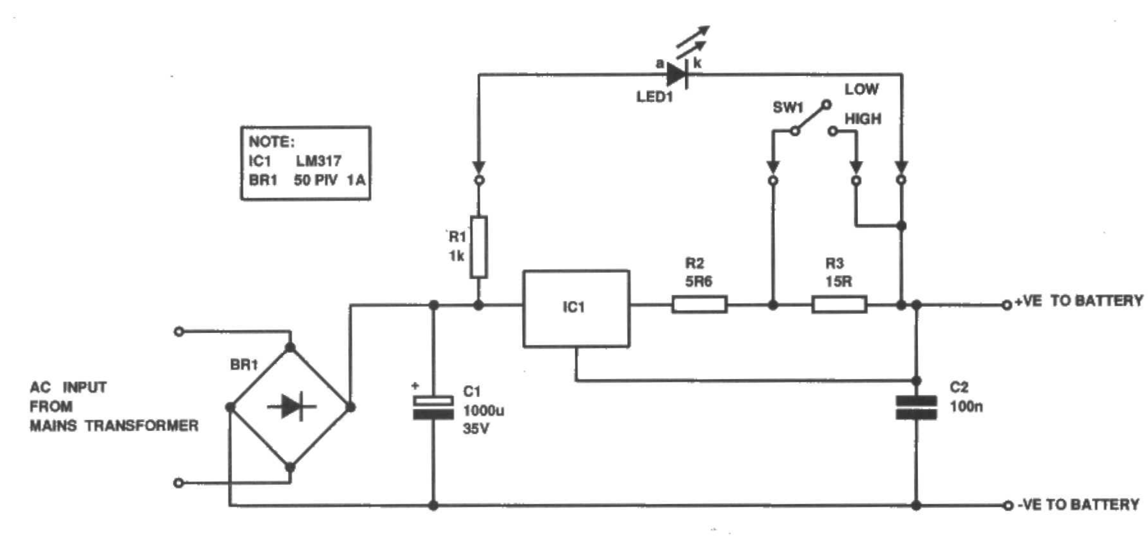


Fig.1 Circuit diagram for the Ni-Cd charger

Ni-Cd Battery Charger

A small but useful project for beginners by Andrew Armstrong.

The best way to charge nickel cadmium cells is to use a constant current source. A Nickel-Cadmium cell has a very low internal resistance, so, if a constant voltage charger is used, minor voltage variations will alter the current substantially. The voltage of a cell changes while it is being charged, so constant voltage charging is quite useless.

The first obvious answer would be to use a constant voltage higher than needed to charge the battery, and to supply the battery via a resistor to limit the current. This approach does work, but the charging current still decreases as the battery charges. If the voltage dropped across the resistor is a substantial fraction of the fully charged battery voltage, then the variation is less, but a lot of power is dissipated in the resistor. If, on the other hand, the voltage dropped across the resistor is only a small percentage of the battery voltage, the current will fall markedly as the battery charges.

This could be an advantage if the battery might be left on charge for a long time before anyone remembers to disconnect it, because overcharge at a low current will cause less harm to the battery, but it is disadvantageous if the battery has to be charged and then used. In this case, a known charging current will guarantee full charge after a set period of time.

It is normal to refer to charging current as a proportion of the ampere hour capacity of the battery, so for example the C rate of charge would deliver 2Ah per hour to a 2Ah battery. The efficiency of charging a 'Nicad' is such that more ampere hours of charge than the nominal capacity of the cell must be supplied to charge it completely.

It is normal to charge 'Nicads' at the c/10 rate for 14 or 16 hours, according to the instructions for the particular cell type. For example, a 2Ah battery would be charged at 0.2A for 14 hours to charge it fully. This rate is chosen because it is the highest rate at which overcharge can continue for a moderate period of time with little damage. If a timer is incorporated to switch off the charge after a required time, or if temperature sensors are employed to detect the increase in battery temperature due to overcharge, faster charging regimes are possible. Seven-hour rather than fourteen-hour charging is acceptable for most types of cell, and the very best can be charged in as little as half an hour.

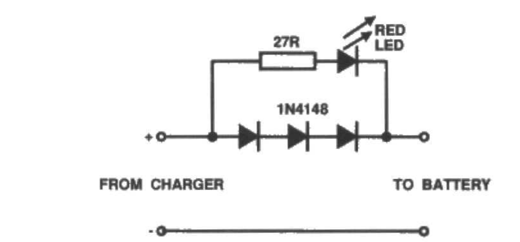


Fig.2 Low current indicator circuit

The charger in this project was designed to charge a battery pack in 14 hours, with a trickle charge option can be used to maintain the charge in the battery pending use, without causing damage due to overcharge. It also has an LED indicator to show whether or not charging current is flowing, and whether trickle or full charge current is in use.

The circuit, shown in Figure 1, was built to charge a set

of ten C cells of 2.2Ah capacity, permanently built into a special lighting effect unit. The battery pack was used to power a powerful quartz halogen car headlamp bulb, so it was vital to know that it started fully charged to get adequate power from it.

As shown in Figure 1, the charger uses an LM317 voltage regulator to maintain a constant 1.2V across a fixed resistor, providing a constant current dependent on the value of the resistor.

When SW1 is on, the output current is 1.2V/5.6R = 214mA, close enough to the recommended charging current of 220mA. With the switch off, the charging current is 58mA, which is approximately the c/38 charging rate.

The LED indicator is powered by the voltage drop in the regulator, so that it is extinguished when there is no load. This was important, because a connection failure could otherwise leave the battery uncharged without giving any indication that there is a problem. The current flowing in the LED also goes to charge the battery, so an additional 5 to 10mA must be added to the currents calculated above.

Because the output voltage of the transformer decreases as the load is increased, the LED is brighter on low charging current, and dimmer on high current. This is opposite from what most people would expect, but it did not seem worth the complexity to make it work the other way round.

The transformer voltage must be chosen to match the battery to be charged, so that the LM317 always has enough voltage across it to work, but is not called on to dissipate too much power. To charge the 12V (nominal) battery pack, a 15V 6VA transformer was used. Other voltages may be selected as appropriate.

The reasoning to select transformer output voltage is as follows: The positive and negative peak output voltage of the transformer is $\overline{2}$ ∞ stated voltage. The reservoir capacitor would charge to this voltage, less the voltage drop in the bridge rectifier, but for the clipping of the tips of the sinewave output as soon as load current is drawn. So the capacitor voltage is approximately (rated voltage ∞ $\overline{2}$) - rectifier drop - sag. If the rectifier drops 1.6V on load, and the sag is about 15%, then the reservoir capacitor voltage on load with a 15V transformer would be 16.7V.

The use of a voltage regulator to set the charging current instead of a resistor is not justified in cases where only one cell at a time is to be charged. In such cases, the dissipation in the regulator would exceed the power delivered to the battery, and a simple current limiting resistor would be more efficient.

If an LED indicator is required in such a case, the circuit of Figure 2 may be used. This diverts most of the current through the 1A diodes, with a small part passing through the LED. The voltage drop in this indicator is approximately 2V, which means that if a D cell is to be charged the dissipation in the diodes will total almost 2W. It also means that the value of the current limiting resistor must be calculated taking this extra drop into account. It is probably best in such cases to check that the charging current is as expected once the calculated resistor value has been inserted. Transformer always give the right answer. Clearly, the charging currents may be selected for different capacities of battery pack, by changing the values of R2 and R3. If a pack of AA sized cells is to be charged, the LED current (which is added to the charging current) may be a substantial fraction of the total charging current needed. For such low current charging (20mA is the normal figure for such cells), it is probably better to use a current limiting resistor in series with an LED.

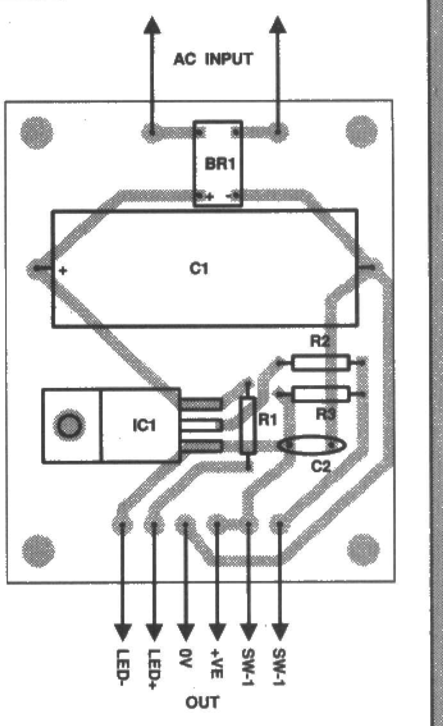


Fig.3 Component Overlay

PARTS LIST

RESISTORS
R1 1k
R2 5R6
R3 15R

Note: The values of R2 and R3 should be recalculated for different battery capacities.

CAPACITORS
C1 1000µ 35V axial electrolytic
C2 100n 0.2" pin spacing polyester or ceramic.

SEMICONDUCTORS
BR1 1A 50V DIL bridge
IC1 LM317 voltage regulator
LED1 Any red LED

MISCELLANEOUS
SW1 Miniature on/off switch Heatsink for LM317
Mains transformer, chosen to suit battery pack.

IC Tester

An easy-to-build IC tester for the laboratory by Shabaz Yousaf

The project described here can be used to check many kinds of ICs in-circuit. Often if a circuit is faulty and an integrated circuit is suspected, all that can be done is to take readings with a multimeter at various terminals of the IC, and these are compared with expected readings from a circuit diagram. The obvious disadvantage is that only one terminal can be examined at a time, and here is where the IC Tester comes in. It clips over any IC of up to 16 pins. The LEDs on the front panel then light up to indicate the voltage (relative to 0V, or the most negative PD) on each pin. Clearly this is not exactly as accurate as a voltmeter, but often all that is needed is a rough idea of the voltage on each pin, the most obvious example being a logic IC.

This design can be used to test ICs operating from 3 to 20 volts, although at the lower voltages the display will be quite dim. The tester does not require any batteries, as it draws it's power from the circuit under test, via the IC it is clipped to.

The IC tester is not in the same league as logic analysers and multiple-trace oscilloscopes, but neverthless is a very useful gadget to have on the test bench. It is invaluable in schools, where pupils can use it as a sort of 'multiple logic probe' for evaluating- the operation of logic gates. Although the component count is quite high (there are no less than 96 components on a board measuring 43x45mm, which equates to a component density of 32 components per square inch!!!). It is a reasonable cheap device, so several could be knocked up for a classroom.

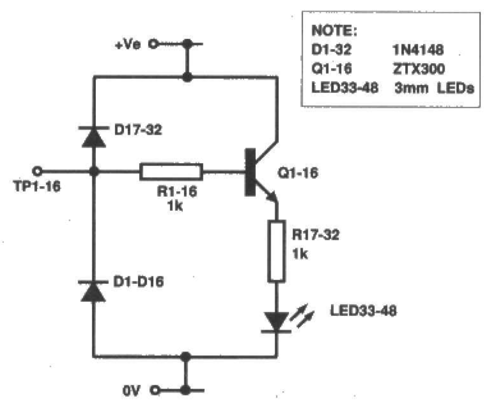
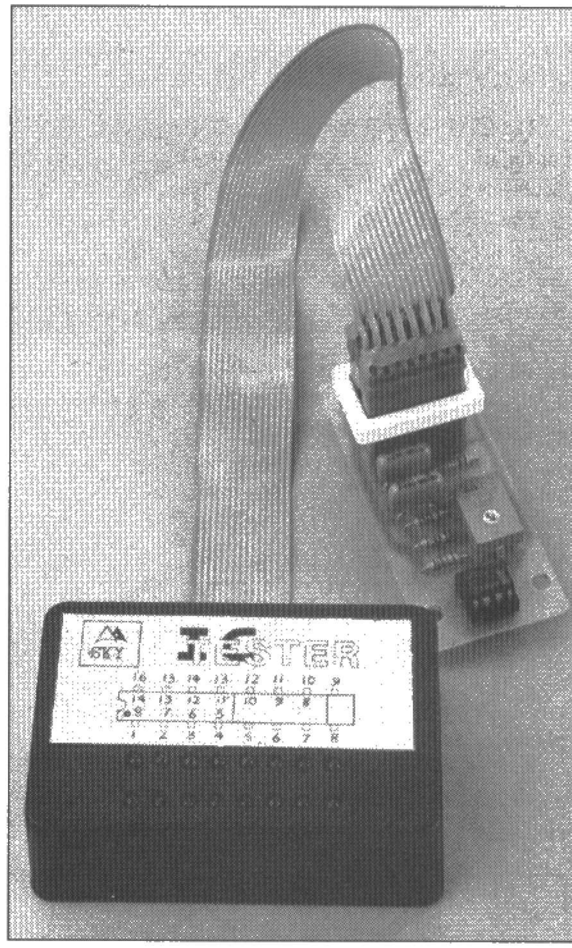


Fig.1 Circuit for IC tester

HOW IT WORKS

Diodes D1-32 are used to divert the voltage on each test pin. If the voltage is positive, it goes to the +ve supply line. Current at the base of a transistor will turn it on, thus lighting the relevant LED. With a voltage of 20V at the base, and taking a voltage drop of 0.7V through each diode, a current of 18.6mA flows through the LEDs.



The Circuit

The circuit diagram in Figure 1 shows just one-sixteenth of the circuit, for simplicity. Sixteen versions of the circuit are constructed on the PCB, each one connected to the other via the +V and 0V lines. The test points are numbered TP1-16, and these go to the IC test clip. Rather like a clothes peg, this can be clipped to any- 0.3" pitch DIL integrated circuit. This covers most ICs, apart from microprocessors, EPROMs and a few others.

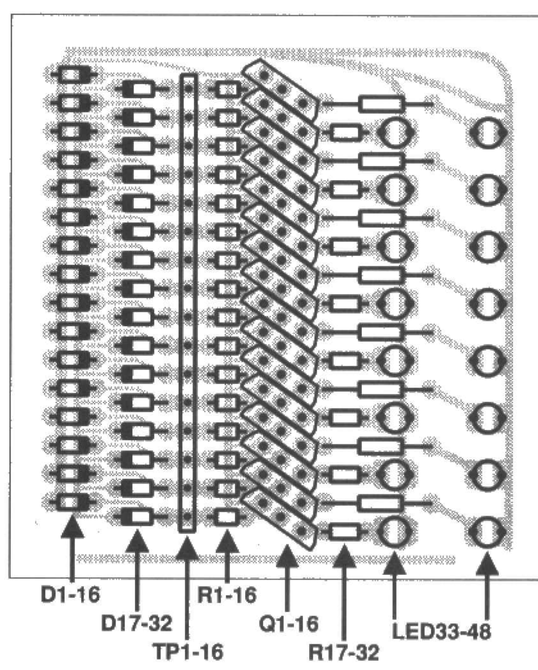


Fig.2 Component Overlay (1 times normal size)

PROJECT

The LEDs in the prototype were standard 3mm red ones, but the use of high efficiency LEDs will give an improved display at the lower voltages.

The design uses an individual transistor for each IC pin, which may deem unneccessarily complicated, considering that two octal driver ICs could have been used instead. However, this would have restricted the voltage range to around 4-6V, which would mean that only TTL devices could be tested. If, however, this is all you want from an IC Tester, replacing resistors R17-32 with 270R will give a much brighter display.

Almost any transistor could have been used in this design, but due to size of the PCB, only the compact ZTX300 will do.

Construction

Figure 2 shows the component overlay for the PCB. Starting from the left, first solder in the diodes D1-32. These are specified in the parts list as 1N4148 types, but almost any small-signal silicon diodes will do. Indeed, the prototype actually used diodes of unknown specification, which were purchased in bulk.

Next, solder in resistors R1-16, transistors Q1-16 then resistors R17-32. If you are using the normal 0.25W resistors, they will have to be mounted vertically on the board. If you can obtain the miniature 0,125W types, these will fit horizontally.

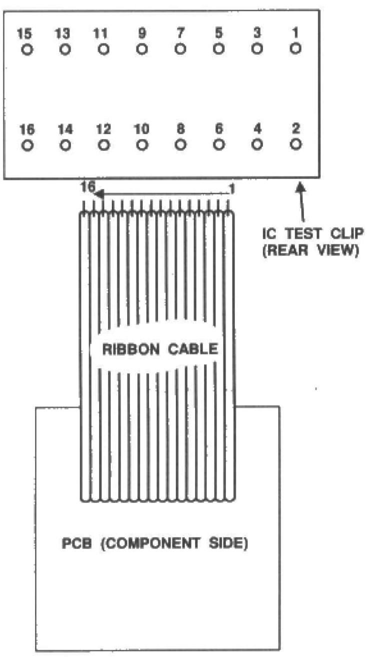


Fig.3 Interconnection diagram

The LEDs are soldered onto the track side of the PCB, protruding about 5mm off the board. LEDs are easily damaged by excess heat, so extreme care must be taken while soldering these in. The 3mm types seem to be more fragile than 5mm types, so it is advisable to purchase a couple more, in case you damage some.

The sixteen-way ribbon cable is soldered to TP1-16, but it is easier to solder PCB pin strips to the PCB, and then solder the cable onto them (see photograph). The ribbon cable must be soldered to the test clip in the correct order, to get an intelligable display, as shown in Figure 3. All the odd-numbered wires are soldered to the top row of the test clip, and the even numbered wires to the bottom row,

The IC tester is such a compact device, it will fit in virtually any enclosure. Figure 4 shows the front panel and hole-drilling template for the recommended case. In order to ensure accurate drilling of the holes, a photocopy of Figure 4 was stuck onto the case with tape, and the hole positions marked with a centre-punch. If you are using an electric drill, running it at a slow speed will prevent the plastic from melting. A shallow notch will be required at the back of the case for the ribbon cable.

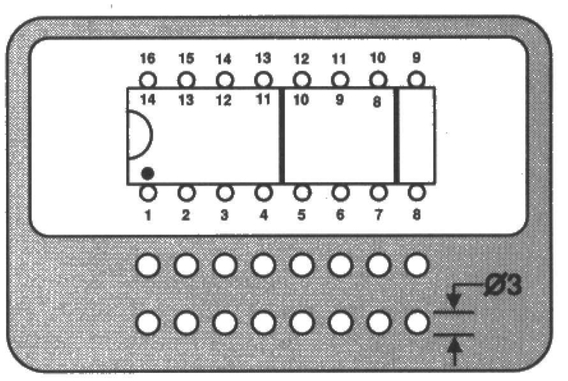


Fig.4 Front panel detail

The PCB is gently pushed into place, and, assuming that the LEDs and the holes are nicely aligned, no problems should be encountered. The PCB is secured in place with a piece of foam (to squash the PCB in place), or some glue. Finally, the lid is screwed onto the case.

Testing

Before you go unscrewing your computer to start plugging in the IC Tester all over the place, it is advisable to test your IC Tester. Get hold of a PP3 battery and clip. Touching the negative (black) lead to any pin on the test clip, running the red lead across the other pins should cause the relevant LED to light in sequence. This is not a thorough test, so you may feel like breadboarding a few simple logic circuits, and using the IC tester to verify the expected results. The device can also be used with analogue audio circuits, although the results are sometimes unexpected. The best light display can be obtained by plugging it onto chips inside a computer. The author hasn't blown his computer up just yet, although it did crash when fiddling with the clock generator ICs.

PARTS LIST

RESISTORS all 1/4 or 1/8W
R1-32 1k

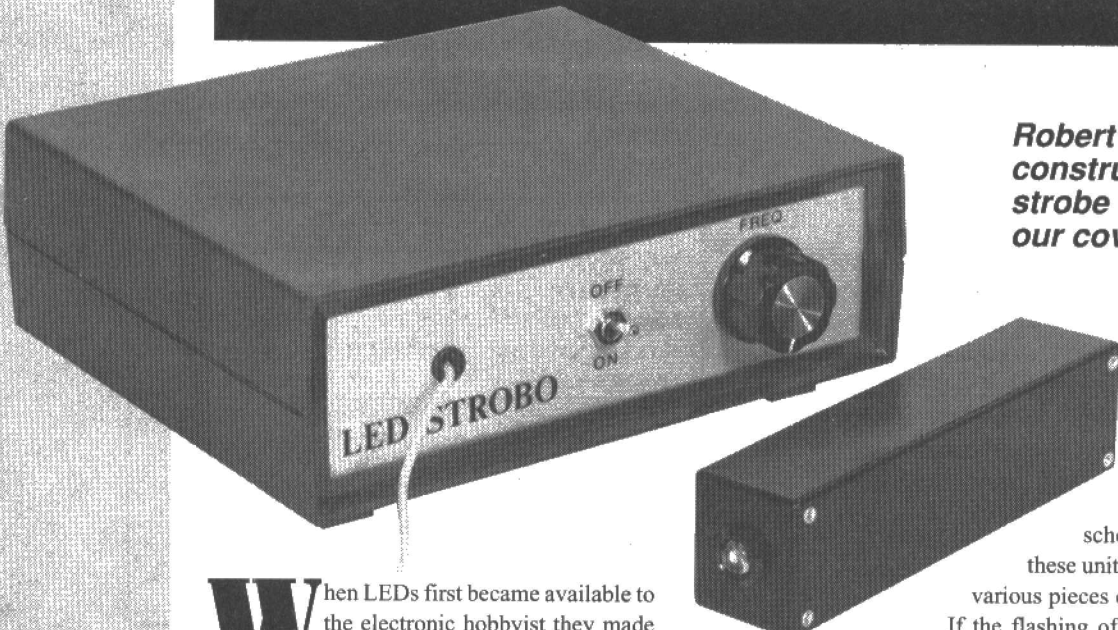
SEMICONDUCTORS
D1-32 1N4148
D33-48 3mm high efficiency red LEDs
Q1-16 ZTX300

MISCELLANEOUS
16 pin 0.3"pitch IC test clip
Box
Foam or glue
PCB, PCB pins

BUYLINES

All components are easily available. The box and IC test clip were purchased from Electrovalue. Greenweld sell packs of diodes at very reasonable prices.

LED Stroboscope



Robert Penfold constructs a portable strobe using our cover PCB

When LEDs first became available to the electronic hobbyist they made an immediate impact, and seemed to feature in practically every project. If there was no good excuse for including a LED or two, then a poor one would suffice. Despite their popularity, the early LEDs had rather poor performance. In particular, even when run at 20 milliamps or so they were often not particularly bright. They would produce a reasonable amount of light from low currents, and in the interest of battery economy were often run at quite modest currents. However, in even moderately bright conditions it was often impossible to see whether or not a LED was switched on.

Matters have gradually improved over the years, and there are numerous 'mega' LEDs to be found in any of the larger component catalogues. The maximum light output levels have gradually increased as first 'high-brightness' types appeared, then 'super-bright' LEDs, and then 'ultra-bright' LEDs became available. The manufacturers seem to have run out of superlatives for anything beyond the latest 'hyper- bright' LEDs. These offer a typical light output of 1.6cd at 20 milliamps, which is a few hundred times higher than the LEDs I first used nearly twenty years ago. Apparently some recent LEDs achieve even higher outputs, but as yet I have not tried out anything beyond a 1.6cd type.

Stroboscope

The high light output levels of the new hyper-bright LEDs opens up new applications. In the past stroboscopes for educational and scientific use have been based on flash tubes, which provide very high light output levels and suitably brief flashes. Anyone who has studied physics at school should remember using these units to 'freeze' the movement of various pieces of machinery.

If the flashing of the stroboscope is synchronised with the machinery, the flash will always occur with the moving parts in the same positions. An onlooker only sees the machinery during the flashes, and it therefore seems to be stationary. The real trick is to get the stroboscope slightly out of synchronisation. With the machinery moving on very slightly from one flash to the next, the result is a sort of slow-motion effect. Getting things out of synchronisation in the opposite direction has much the same effect, but the machine will seem to run in reverse.

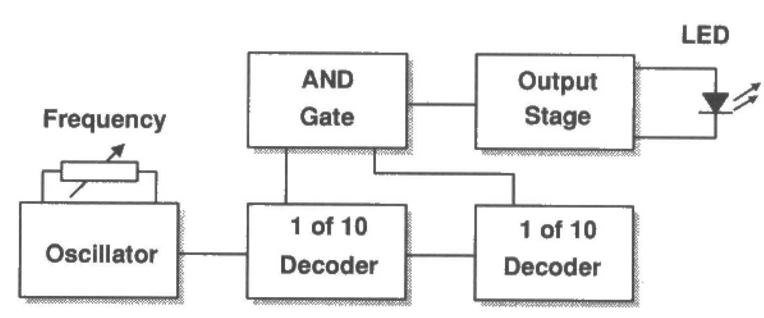


Fig.1 Block diagram of LED Stobe

Conventional stroboscopes are not necessarily very complex, but they do require some special and relatively expensive components. Also, high voltages are involved, which no doubt deters many from building this type of equipment. A modern LED offers a simple, inexpensive, and safe alternative, but it has to be pointed out that an LED, even one of the best modern types, offers a far lower light output level. An LED based stroboscope is only usable with small pieces of machinery, and in a well darkened room. Although it has its limitations, an LED stroboscope makes an interesting 'fun' project which can be built at minimal cost.

Flashing LEDs

On the face of it an LED stroboscope is just a very simple flashing LED type project. In reality matters are rather more complicated since the LED must be flashed very briefly if the desired slow-motion effect is to be obtained. It is the mark-space ratio of the drive signal that is crucial. Suppose that the stroboscope is being used to 'freeze' a drive shaft, and that it will flash once per rotation of the drive shaft. If the LED is switched on for (say) 25% of the time by a 1 to 3 mark-space ratio, the shaft would rotate through 90 degrees during each flash. This would clearly give such a blurred image that it would be of no real value.

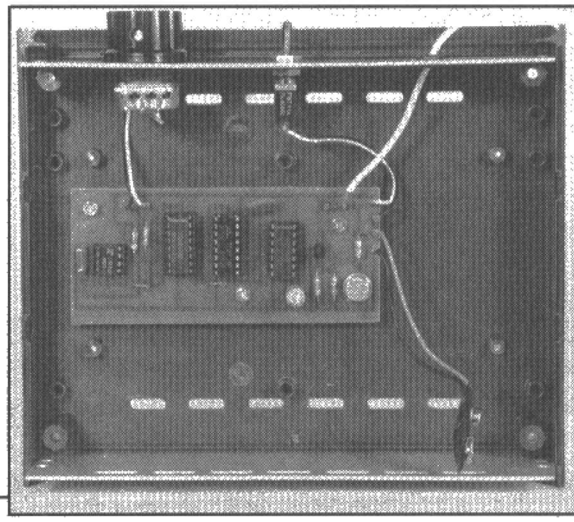
Ideally the mark-space ratio would be very high indeed, at perhaps 1 to 1000. As is usually the case when designing electronic circuits, there are conflicting interests. A high mark-space ratio means that the average LED current is very low, with a corresponding low LED brightness. If we take the 1 to 1000 mark-space ratio, a pulse current of 20 milliamps would give an average current about 1000 times less, or about 20 microamps in other words. This would probably not produce a discernible light output from the LED.

Another problem with a high mark-space ratio is that it requires a wide bandwidth from the LED in order to prevent the pulses from becoming smeared. With a maximum pulse frequency of a few hundred Hz the LED would require a bandwidth of a few MHz in order to accurately follow the drive signal. Unfortunately, most LEDs are relatively slow by semiconductor standards, and do not have suitably wide bandwidths.

To some extent the problem of reduced average current can be combatted by using a high pulse current. Although most LEDs have a maximum continuous forward current rating of only about 30 milliamps, they can usually take peak currents of around one amp provided the mark-space ratio is high enough to keep the average current down to a safe level. However, the actual 'on' time of the LED must be quite short so that on each pulse the LED does not have time to break down or simply burn out. After some experimentation I settled for a mark-space ratio of about 1 to 100 and a pulse current of about 1 amp. This gives an average LED current of around 10 milliamps, and reasonable LED brightness. It also gives a reasonably sharp 'frozen' image.

System Operation

At its most basic the circuit could simply consist of an oscillator having a suitable mark-space ratio. The problem with this approach is that the frequency of oscillation must be variable so that the flashes can be accurately synchronised with the machinery. It is difficult to produce a variable frequency oscillator that will accurately maintain a high mark-space ratio. It is better to use a simple oscillator plus some logic circuitry. The block diagram of Figure 1 helps to explain the way in which the unit functions.



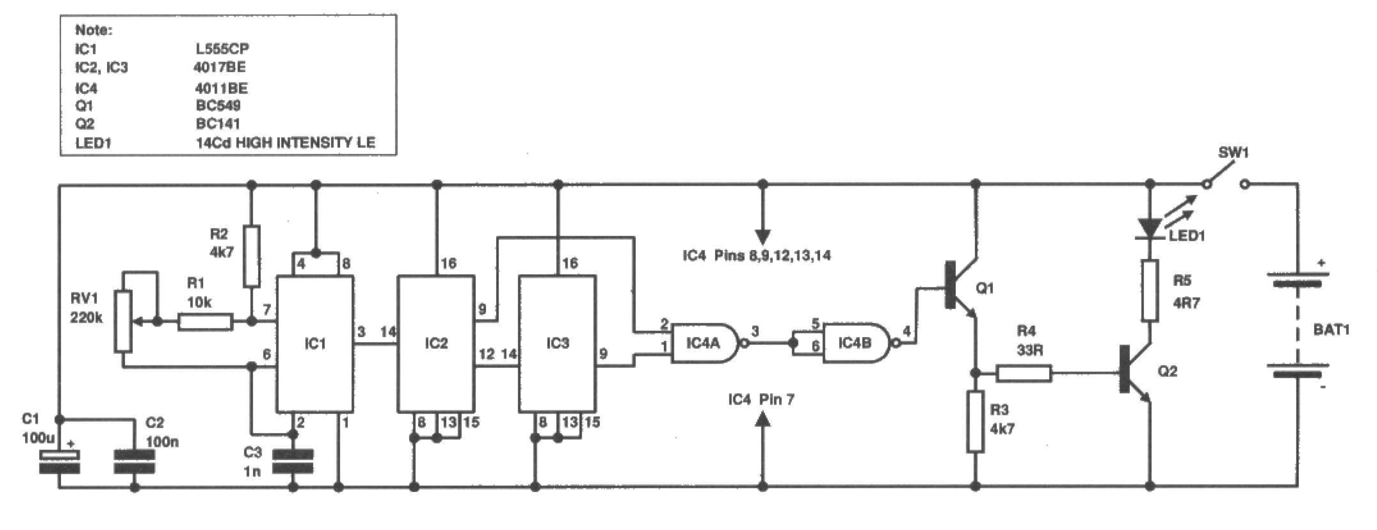


Fig.2 Circuit diagram of LED Strobe. Frequency range being about 20-400Hz

A variable frequency oscillator provides a clock signal at one hundred times the output frequency. This operates over a frequency range of approximately 2 to 40kHz, giving an output frequency range of around 20 to 400Hz. This may seem to be a rather low maximum output frequency, but 20 to 400Hz equates with an RPM range of 1200 to 24000. This should be adequate for most purposes, and probably represents something close to the maximum range that the LED can handle successfully.

The oscillator drives two one of ten decoder circuits connected in series. A circuit of this type has ten outputs with

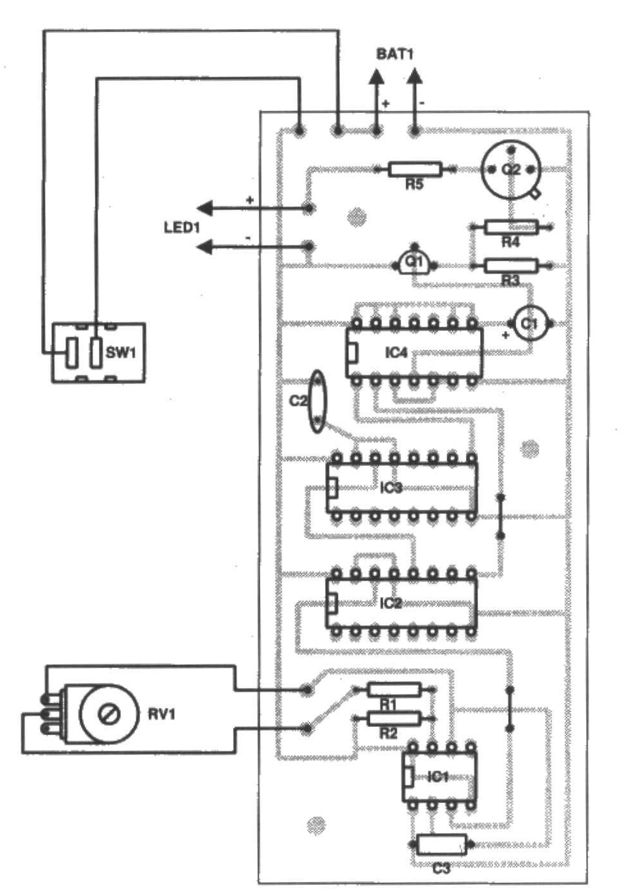


Fig.3 Component overlay and external wiring

each one going high, in sequence, for one clock cycle. Therefore, the output from both of these circuits is a pulsed signal having a 1 to 9 mark-space ratio, but with one signal at ten times the frequency of the other. The required 1 to 100 mark-space ratio is obtained by feeding one output of each decoder into and AND gate. This gives an output signal that is high only when both of the outputs driving it are high. This occurs on one clock cycle per hundred input cycles. To be strictly accurate the actual mark-space ratio is 1 to 99 rather than 1 to 100, but this is of no practical significance. A simple two transistor output stage drives the LED with a suitably high pulse current.

Circuit Operation

Figure 2 shows the full circuit diagram for the LED Stroboscope. The variable frequency oscillator is a straightforward 555 astable circuit having RV1 as the frequency control. I did not find it too difficult to accurately adjust the output frequency using RV1, but simply add a 4k7 linear potentiometer in series with RV1 if a fine frequency control is required. A low power version of the 555 timer is used in order to keep down the current consumption of the circuit, and provide better battery life. The current consumption of the circuit is actually little more than the 10 milliamps drawn by the LED.

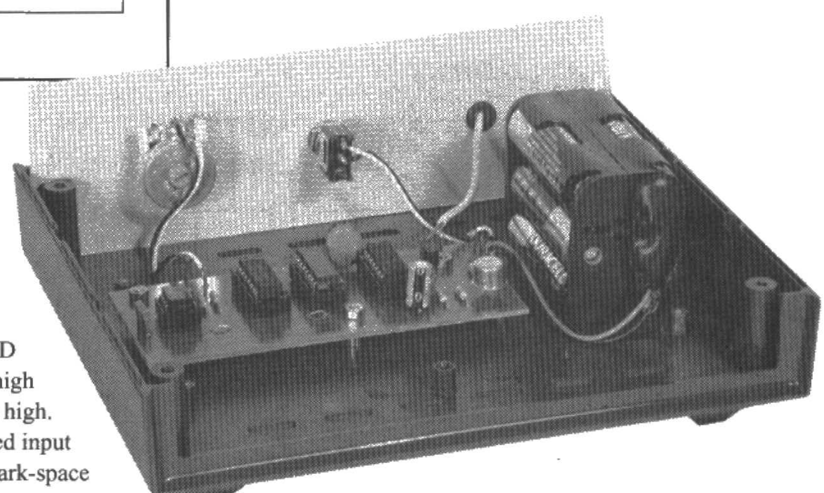
IC2 and IC3 are the one of ten decoders. These are both CMOS 4017BEs connected as simple divide by ten circuits. Note that it does not matter which one of the ten outputs of each device is used to drive the gate circuit. Whether the LED is activated on 43rd pulse in each count or the 89th makes no difference, it will still be pulsed for one clock cycle in every hundred cycles. For the record, the LED is pulsed when the count on IC2 and IC3 is 88.

The AND gate function is provided by IC4. This is actually a NAND gate followed a second gate wired to give an inverter action. The other two gates in IC4 are left unused, but their inputs are wired to the positive supply to prevent spurious operations. The output stage has Q1 as an emitter follower driver stage, and Q2 as a common emitter switch to drive the LED (LED1). R5 is a current limiting resistor.

Construction

Details of the printed circuit component layout and the small amount of point-to-point wiring are provided in Fig.3. The board is very simple and straightforward to build, but do not overlook the two link wires. The four integrated circuits are CMOS types, but the L555CP used for IC1 has built-in protection circuits which render the usual anti-static handling precautions unnecessary. It is probably best to fit all four integrated circuits in holders anyway. Note that any low power 555 should be suitable for IC1 (L555CP, ICM7555CP, TLC555CP, etc.). At this stage only fit single- sided pins to the board at the positions where connections to off-board components will eventually be made.

Due to the limited light output of the LED it is best to mount LED1 in its own



probe-like case. Any small plastic or metal case should suffice. The probe case used for the prototype is a plastic type having outside dimensions 124 by 33 by 30 millimetres. This is somewhat larger than is really necessary, but it is convenient in use. I tried Maplin 8 and 10 millimetre diameter hyper-bright LEDs for LED1, and the 8 millimetre type seems to give the best results. This is due to the move even intensity across the beam of light - there is no apparent difference in their light output levels.

Any LED having a light output of about 1.6cd or more at 20 milliamps should be usable, provided it has a reasonably narrow viewing angle (i.e. about 25 degrees or less). The higher the light output rating the better. It might be worth looking through a few recent catalogues to see what is available. These components are not particularly expensive, so it costs little to experiment with different types.

The main case can be virtually any small instrument type,

but make sure you choose one that can accommodate the relatively bulky battery. The latter consists of six HP7 size cells in a plastic holder. Connections to the holder are made via a standard PP3 battery clip.

The general layout of the unit is not critical, and any reasonably sensible layout will do. The LED probe can be connected to the main unit via a two way plug and socket, but direct connection to the circuit board is probably a better method in this case. If you use a plug and socket, use a type that can comfortably accommodate fairly high currents.

In Use

Once the small amount of point-to-point wiring has been added the unit is ready for testing. Initially it is probably best to have a 100R resistor in series with LED1. This will keep the LED current to a safe level if there should happen to be a fault that results in LED1 being switched on continuously. Bear in mind that such a fault would give the LED a life expectancy of well under a second. Once you have established that the unit is functioning correctly the extra resistor can be removed.

At the low frequency end of the range the LED will noticeably flicker. At most frequencies though, it will appear to light up continuously. You can confirm that it is still flashing by simply waving the LED around. This will produce a 'dotted line' rather than a continuous line of light.

Optimum results will be obtained with the unit set for one flash per rotation, swing, or whatever, of the moving part that is being 'frozen'. If you set the unit for two or three flashes per mechanical cycle a double or triple image will be produced (with each image a half or one third normal brightness). With the stroboscope set for one flash every two or three mechanical cycles a single image will be obtained, but the 'frozen' image will have reduced clarity. It is really a matter of experimenting with various settings for RV1 to find the one that gives the correct type of synchronisation.

One final point is that due care should be taken when operating near any piece of machinery. Even small pieces of machinery can inflict nasty injuries if you are not careful. Always keep well clear of any moving parts.

PARTS LIST

RESISTORS
R1 10k
R2,3 4k7
R4 330R
R5 4R7
RV1 220k lin pot

CAPACITORS
C1 100u/10V radial electrolytic
C2 100n ceramic
C3 1n polyester

SEMICONDUCTORS
IC1 L555CP, ICM555, etc
IC2,3 4017BE
IC4 4011BE
Q1 BC549
Q2 BC141
LED1 Ultra-bright LED (see text)

MISCELLANEOUS
SW1 SPST min toggle
B1 6xHP7 size cells in holder
Case, Led holder, Control knob, battery clip, small case for LED.

BUYLINES

A 10mm diameter 14Cd Ultra-bright LED is available from RS Components £8.75 (Code no. 577-825)

Ray Marston takes an in-depth look at modern electronic analogue volt, current, and resistance meter circuitry in this three-part mini-series.

The effective performance of a moving-coil meter can be greatly enhanced by combining it with one or more transistors, FETs, or ICs; such circuits can be made to act as sensitive AC or DC current meters, or as high impedance volt or millivolt meters, or as linear-scale ohmmeters, etc. This 3-part series takes an in-depth look at a variety of electronic analogue meter circuits of these basic types.

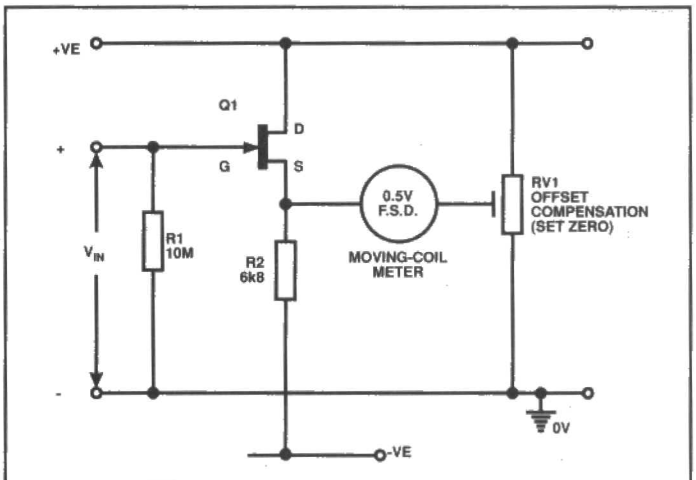


Fig.1 Basic FET voltmeter circuit.

Moving Coil Meters

1

FET Voltmeters.

A true voltmeter consumes zero input current and has an infinite input impedance. A reasonable approximation to this ideal can be obtained by driving a simple moving-coil voltmeter via a voltage-following buffer stage, as shown in the basic circuit of Figure 1. Here, Q1 is an enhancement-mode JFET and generates a positive source voltage when the input voltage is zero; the moving-coil meter is set to read 0.5 volts FSD and is wired between the source and an offset compensation voltage point which equals the zerô-input source voltage; the meter thus reads zero when the input voltage is zero, and reads FSD with an input of +0.5V. Note that the JFETs source resistor (R2) is taken to a negative supply voltage to enhance circuit linearity, and that a 10M resistor is connected across the JFETs input to prevent the build-up of static charges when the input is open circuit.

Figures 2 and 3 show practical 3-range versions of the above circuit, designed to give FSD voltage ranges of 0.5V, 5V, and 50V; each circuit is protected from input overload damage via R4. In each case, RV1 is used to set the meter's basic FSD sensitivity on the 0.5V range, and RV2 is the SET ZERO control.

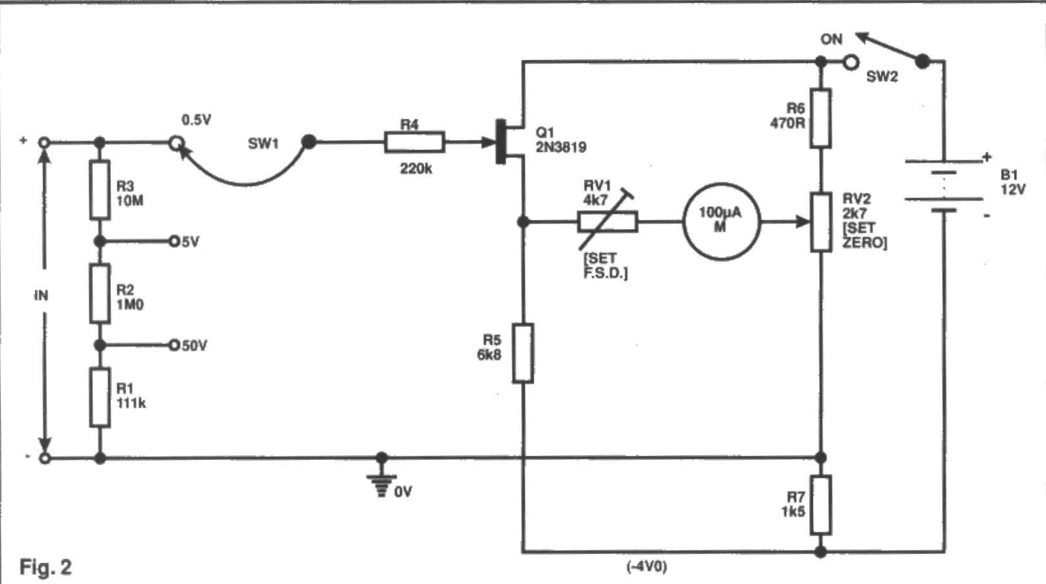


Fig. 2

The Figure 2 circuit is similar to that already described, but uses the simple R6,RV2,R7 potential divider to give offset (Set zero) compensation and to generate a -4V rail from the single supply battery; this circuit is consequently prone to zero-point drift with changes in temperature and supply voltage and needs frequent set-zero control retrimming; drift can be greatly reduced by using a regulated 12V supply.

Figure 3 is a low-drift version of the circuit. Here, Q1 and Q2 are wired as a voltage-following differential amplifier in which any drift occuring on one side of the circuit is automatically countered by a similar drift on the other side, thus giving good overall stability. Q1 and Q2 must be selected JFETs, with their I_{DSS} values matched to within 10%. The circuit can use any supply in the 12 to 18V range.

Basic Op-Amp DC Meter Circuits.

The best way to make a precision electronic analogue DC meter is to wire the moving-coil meter into the feedback loop

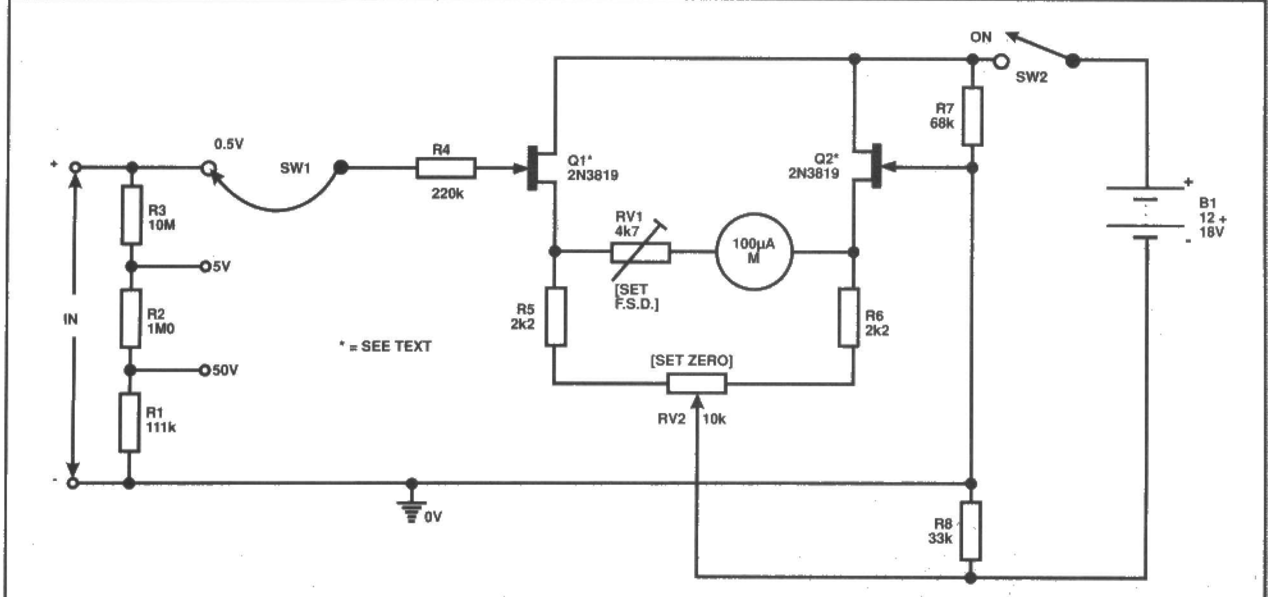


Fig.3 Low-drift 3-range FET voltmeter.

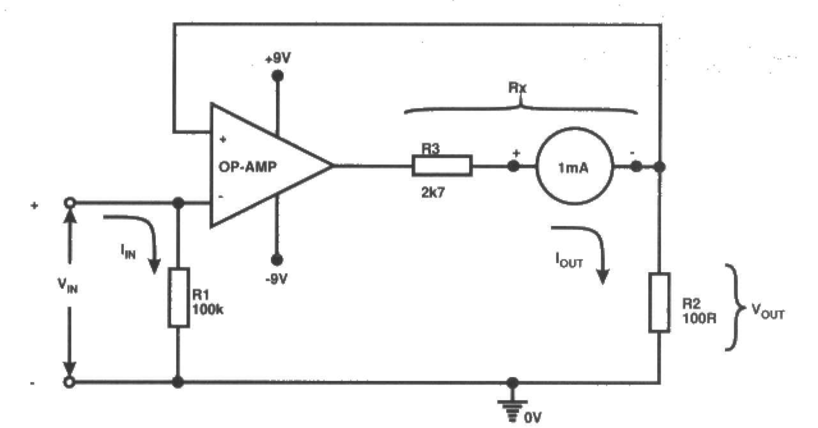
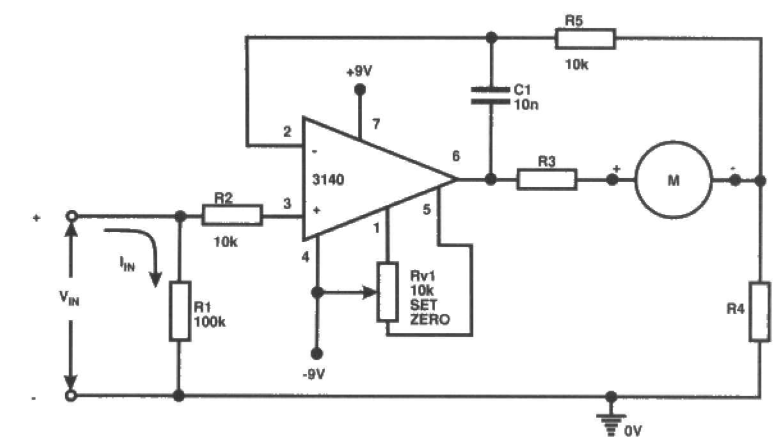


Fig.4 Basic DC current meter circuit has a FSD input sensitivity of 1µA at 100mV.

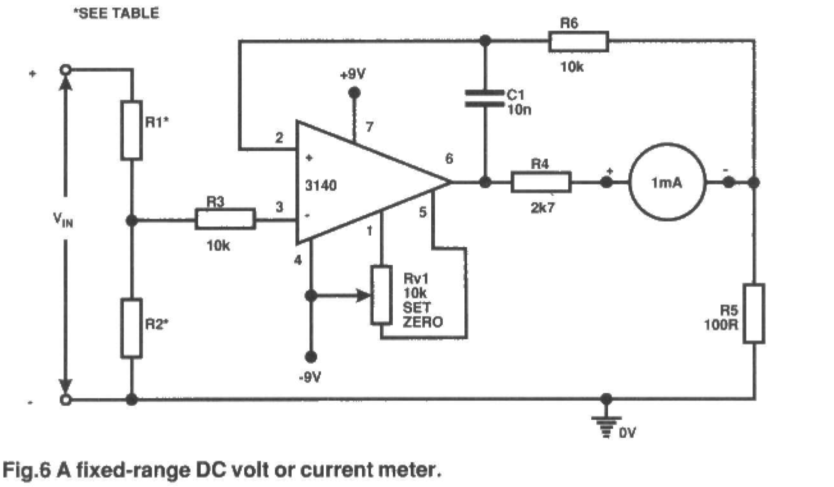
of a modified op-amp DC voltage follower (unity-gain non-inverting amplifier), as sbown in the basic circuit of Figure 4. Note here that Vout = Vin, that Rx represents the series value of R3 and the meter's internal resistance, and that Iout = Vin/R2 and is independent of the Rx value (provided that the sum of Rx and R2 volt drops is less than the op-amp's positive saturation voltage. Thus, when R2 has the 100R value shown the 1mA meter reads FSD at an input of 100mV, and (since a current of only 1µA flows in 100k input resistor R1 under this condition) the overall circuit has an FSD input sensitivity of 1µA at 100mV. Also note that R3 (together with the series resistances of R2 and the meter's coil) limits the maximum output current to less than 3mA when the op-amp output is saturated, and thus provides the meter with automatic overload protection by limiting its maximum current to less than treble its FSD value.

The basic Figure 4 circuit can, by suitable choice of the R2 and R3 values, be used to raise the effective sensitivity of any 50uA to 2.5mA moving-coil meter to 1uA at 100mV, irrespective of the meter's internal resistance value, and gives that meter automatic overload protection. In



METER FSD CURRENT	R3 VALUE	R4 VALUE
50µA	47k	2k0
100µA	27k	1k0
250µA	10k	400R
500µA	4k7	200R
1mA	2k7	100R
2.5mA	1k0	40R

Fig.5 This circuit gives any of the listed current meters an effective FSD input sensitivity of 1µA at 100mV.



FSD	R1	R2
VOLTMETER		
1000V	10M	1k0
100V	10M	10k
10V	10M	100k
1V	900k	100k
100mV	0	100k
CURRENT METER		
1Amp	0	0R1
100mA	0	1R0
10mA	0	10R
1mA	0	100R
100µA	0	1k0
10µA	0	10k
1µA	0	100k

Fig.6 A fixed-range DC volt or current meter.

practice, the op-amp must be a FET type, so that its input impedance does not significantly shunt R1, and must be provided with facilities such as input-overload protection, set-zero control, and stability enhancement. Figure 5 shows a practical version of such a circuit.

The Figure 5 circuit uses a 3140 MOSFET op-amp, and has input overload protection provided via R2 and has set-zero offset nulling provided via RV1 (which should ideally be a multi-turn pot). The 3140 (like most wideband op-amps) tends to be unstable when used in the voltage follower mode, so C1-R5 are used to enhance its operating stability. The table shows suitable R3 and R4 values for use with meters having standard sensitivities in the 50µA to 2.5 mA range. The circuit consumes about 2.6mA from a +/-9V supply when its output is set to zero.

Figure 6 shows how the above circuit (a 1mA version is shown here) can be used as a single-range DC volt or current meter. R1's value is zero in the 'current meter' mode, and R2 is used as a shunt that generates 100mV at the desired FSD current value; in the voltmeter' mode R1-R2 are used as a potential divider that gives a 100mV output at the desired FSD input voltage value.

Multi-range DC Meter Circuits.

Figure 7 shows the Figure 6 circuit modified to act as a 12-range DC voltmeter that spans 100mV to 500V. SW1 provides four ranges of decade switching (x1, x10, x100, and x1000), and SW2 provides three alternative values of range multiplication (x1, x2.5, or x5) by setting the circuit's basic FSD sensitivity to either 100mV (= x1), 250mV x2.5), or 500mV (= x5). The SW1 ranging is achieved by switching the input voltage to various points on the decade attenuator network, which keeps the op-amp's input permanently grounded via 110k of fixed resistance.

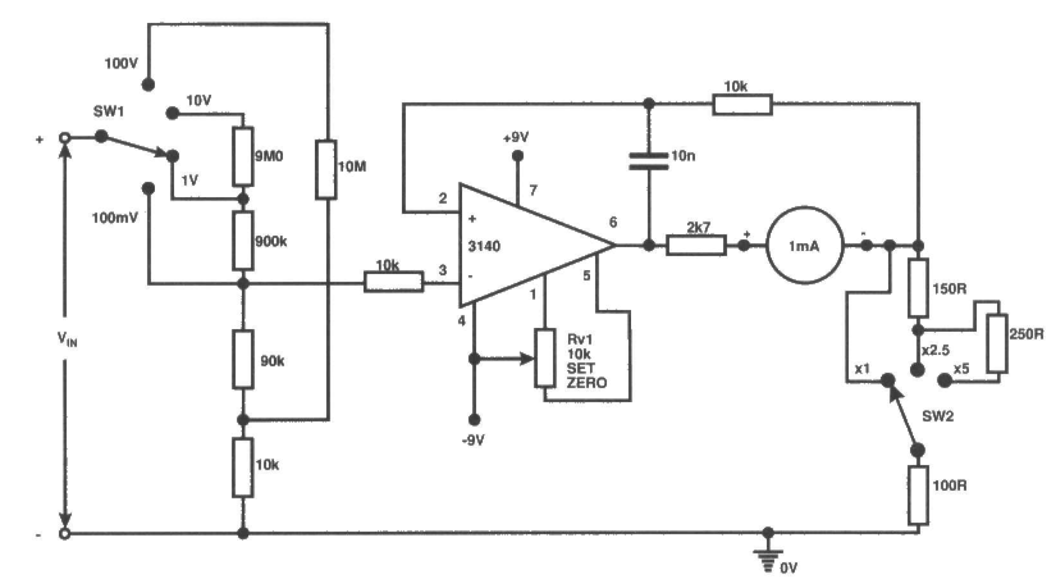


Fig.7 This 12-range DC voltmeter spans 100mV to 500V FSD

Figure 8 shows a multi-range DC voltmeter with an input impedance of 10M on all ranges. Here, the input voltage is permanently connected to the top of the decade attenuator chain, and ranging is achieved by switching the op-amp's input to various tapping points on the attenuator via SW1 (which must be a make-before-break switch). Note that the op-amp's input is grounded by 10 Megohms of resistance when SW1 is set to the '100mV' position, and that under this condition the circuit is highly susceptible to HF instability and to the disturbing effects of leakage resistance between its pin-3 input terminal and the adjacent pin-4 negative supply rail terminal; a mere 10,000 Megohms of resistance between these points will give the meter a negative offset of 9mV (= 9% of FSD).

The above circuit's HF instability problem is overcome by wiring the C1-R1 network between the op-amp's pin-3 and ground, to restrict the circuit's frequency response. The leakage resistance problem is overcome by careful design

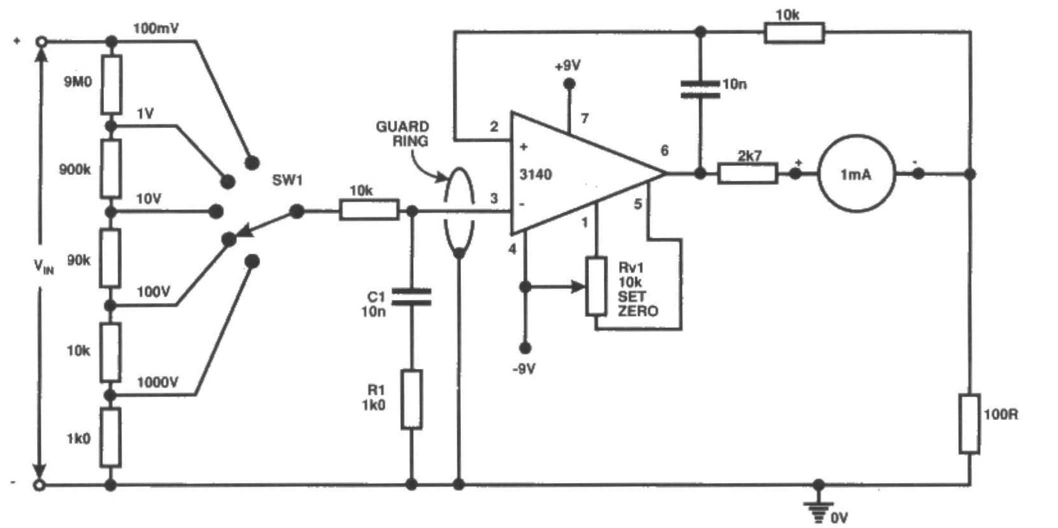


Fig.8 5-range DC voltmeter with 10M input immpedance.

and construction of the circuit's printed circuit board (PCB), in which the PCR area surrounding pin-3 of the op-amp is given a grounded 'guard ring', as shown in Figure 9.

Figure 10 shows how the basic Figure 6 circuit can be modified for use as a DC current meter that spans 1μA to 1 Amp in seven decade ranges. This circuit can be made to span 1μA to 5 Amp in 21-ranges by modifying its output to give x1, x2 5, and x5 range multiplication, as in the Figure 8 circuit.

Finally, Figure 11 shows how the circuits of Figures 8 and 10 can be combined to make a DC meter that spans 1A to 5 Amps and 100mV to 500V in 30-ranges. Note that the 'decade multiple of 9' resistors used here (and in other circuits) can be made by either wiring two '18A' types in parallel or by wiring a '6R8' and a '2k2' type in series, e.g., a 9k0 resistor can be made from two 18k types in parallel or from a 6k8 and a 2k2 value in series.

DC Millivoltmeter Circuits

The basic Figure 5 'DC meter' circuit is a unity-gain non-inverting amplifier with 100mV FSD sensitivity. Figure 12 shows how the circuit can be modified to act as a DC millivoltmeter with a maximum FSD sensitivity of 1mV by making the circuit's gain variable between unity (at 100mV FSD) and x100 (at 1mV FSD) via SW1. Note that

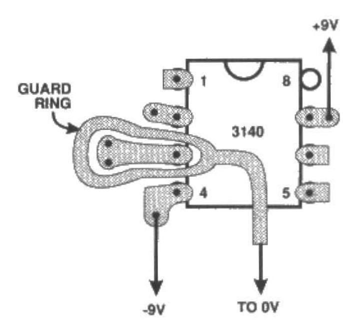


Figure 9 Guard ring etched on a PCB, viewed through the top of the board.

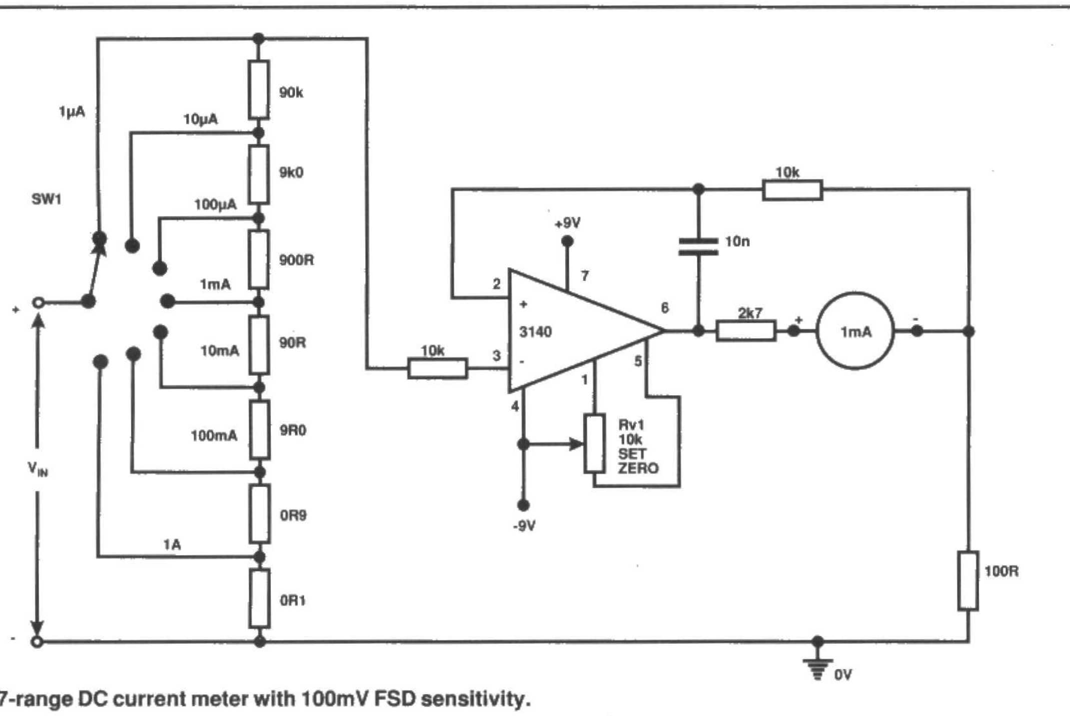


Fig.10 7-range DC current meter with 100mV FSD sensitivity.

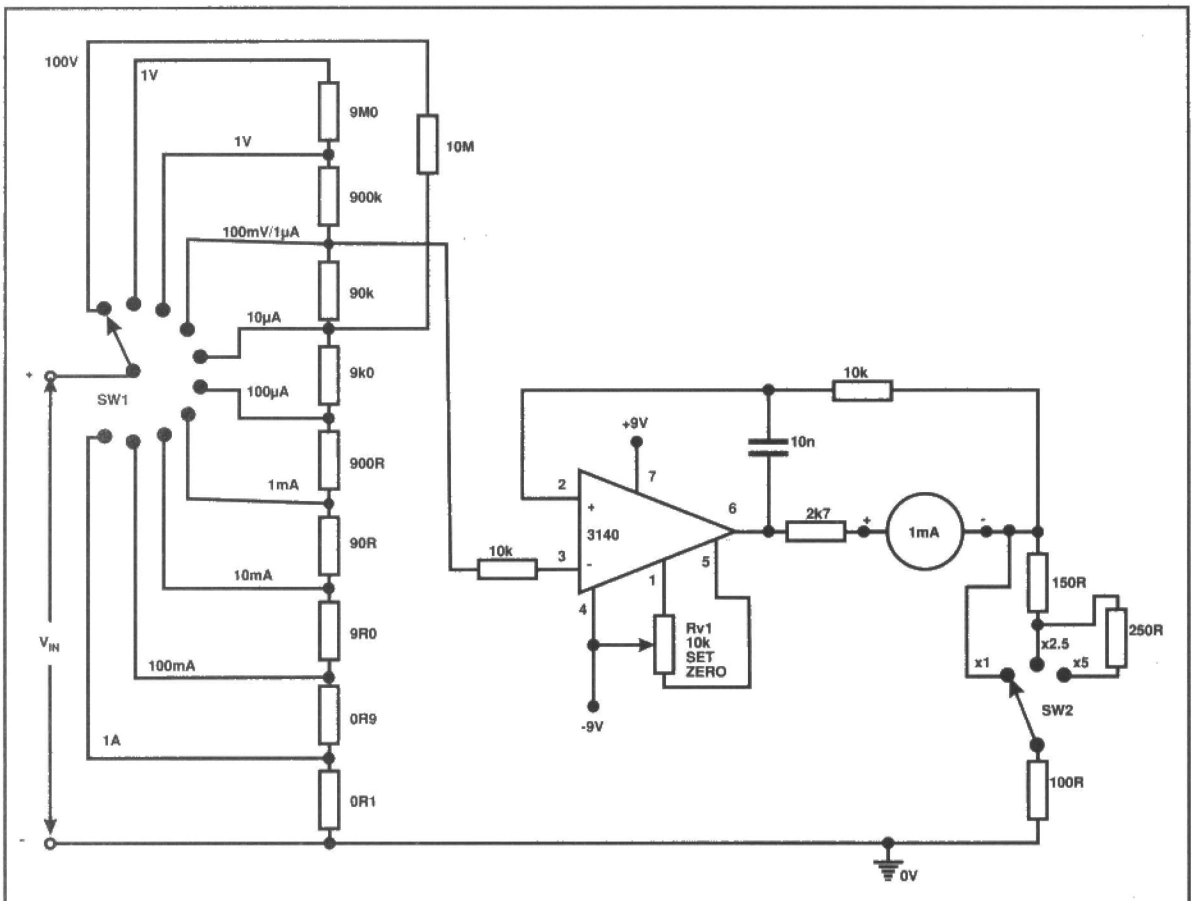


Fig.11 30-range (1μA to 5A and 100mV to 500V) DC volt/current meter.

the sensitivity is so high on the 1mV range (it reads FSD with an input current of only 10nA) that the use of a PCB guard ring and a multi-turn SET ZERO (RV1) control is mandatory; even so, the circuit's balance is prone to drift on this 1mV range and needs frequent retrimming.

An alternative way of making a DC millivoltmeter is via the basic op-amp inverting DC amplifier circuit of Figure 13, which gives a voltage gain (A) equal to the A2/A1 ratio and generates an output voltage (Vout) of -A x Vin. Note that the op-amp's output current is equal to the sum of the currents flowing in R2 (= I_F) and R_L (= I_L), and that if R2 is at least 100 times greater than A1 the Iout value will, most practical purposes, equal I_L. In this latter case the circuit can be used as a DC millivoltmeter by connecting it as shown in Figure 14.

In Figure 14 the 1mA meter is wired in series with the op-amp output and made to read FSD at an output of 100mV via R4, and is given overload protection via R3; the circuit can thus be given an overall FSD sensitivity of 1mV, 10mV, or 100mV, etc., by choosing the R2/R1 values to give a voltage

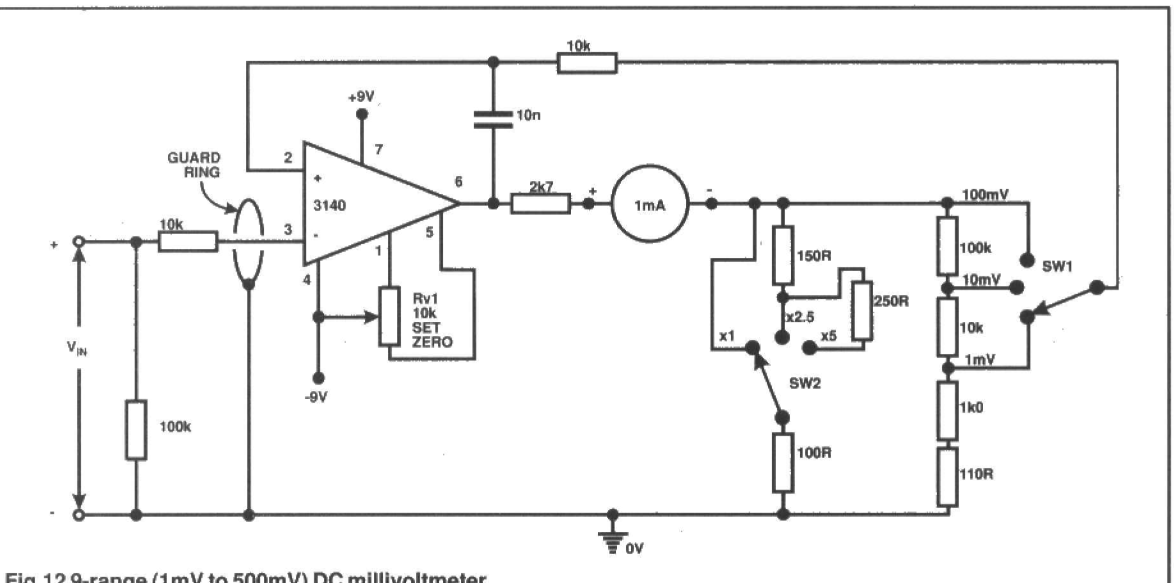
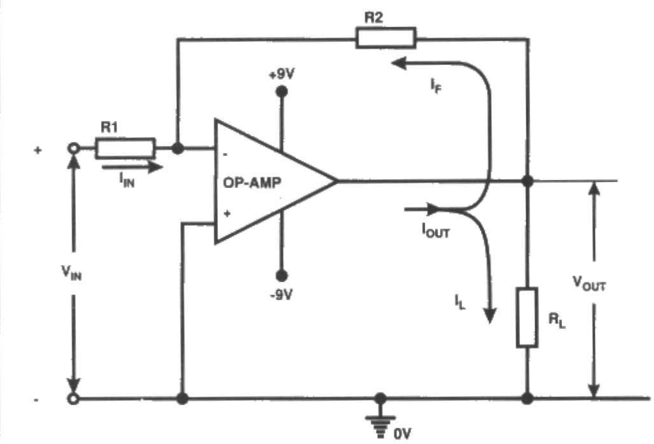


Fig.12 9-range (1mV to 500mV) DC millivoltmeter.

gain of x100, x10, or x1, etc., as shown in the tahle.

Alternatively, Figure 15 shows how the basic inverting amplifier can be used as a converter that enables any 1 volt FSD meter with a sensitivity of 1 mA or better to read values in the range 1mV to 10V FSD, at a basic sensitivity of 1M0 per volt. The voltage range is set by R1, as shown in the table. This circuit's accuracy is not influenced by the relative impedances of R2 and the meter.

When the Figure 14 and 15 circuits are used on the 1mV range they are highly sensitive to the effects of op-amp noise, leakage impedances, and thermoelectric action in the input circuitry. To help overcome these problems, each circuit must be provided with an input guard ring, must have its bandwidth reduced via C1 and C2, and must have its SET ZERO control enhanced by the addition of a 22k resistor between RV1 slider and pin-4 of the op-amp, as shown.



$$A = \frac{R_2}{R_1}$$

$$V_{out} = - A \infty V_{in}$$

$$I_{in} = \frac{V_{in}}{R_1}$$

$$I_F = - I_{in}$$

$$I_L = \frac{V_{out}}{R_L}$$

$$I_{out} = I_F + I_L$$

Fig.13 Basic inverting DC amplifier circuit.

AC Voltmeter Basics

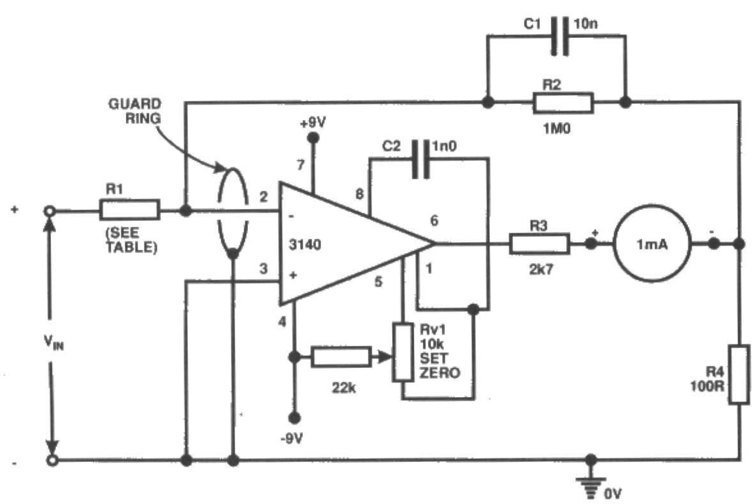
A moving-coil meter inherently reads mean values of DC current, but can be persuaded to respond to AC voltages by feeding them to the meter via a suitable rectifier network and voltage multiplier resistor. The most popular circuit of this type is the well-known bridge-rectifier one of Figure 16a. One major attraction of this circuit is that (unlike many half-wave types of rectifier) it presents the same input impedance on both the positive and negative halves of the input signal; it does not cause unbalanced loading of the voltage source, and can thus be accoupled to the source.

Diode rectifiers are very non-linear devices, and cause simple rectifier-type AC voltmeters to have a highly non-linear scale response to low-value (less than a few volts) inputs. This problem is particularly accute with the Figure 16a bridge circuit, since two diodes are in series with the meter on each half-cycle (D1-D4 on positive halfcycles, D2-D3 on negative ones). Figures 16b and 16c show alternative meter-driving rectifier circuits which have symmetrical input impedances but have only one active diode in series with the meter and thus have improved linearity.

The Figure 16b design is a widely used one that gives a pseudo full-wave rectifier action; on positive half-cycles current flows via Rm-D1 and then divides, part flowing via C2 and part flowing via the meter and C1; on negative half-cycles the current flows via D2-Rm, partly via C1 and partly via C2 and the meter; the circuit's conversion efficiency equals that of a half-wave rectifier, as indicated by its 'Rm' formula.

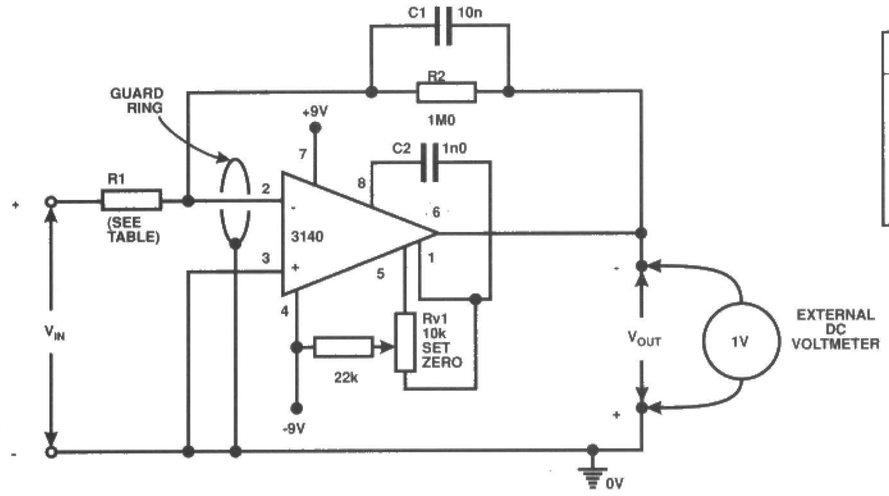
The Figure 16c circuit gives unashamed half-wave rectifier action, with current flowing through the meter via Rm and D2 on positive halfcycles only; on negative ones the current flows via Rx and the Rm-D1 'ghosting' network, thus maintaining the input impedance symmetry. Note that the Rm formula is the same as that of Figure 16b. Ideally, Rx should have the same value as the meter's coil resistance, r, but in practice can be shorted out if Rm is very large relative to r.

It is important at this stage to understand that simple meters of the Figure 16 type can be used at fairly low voltages (possihle down to less than 1 volt FSD) and that in such cases



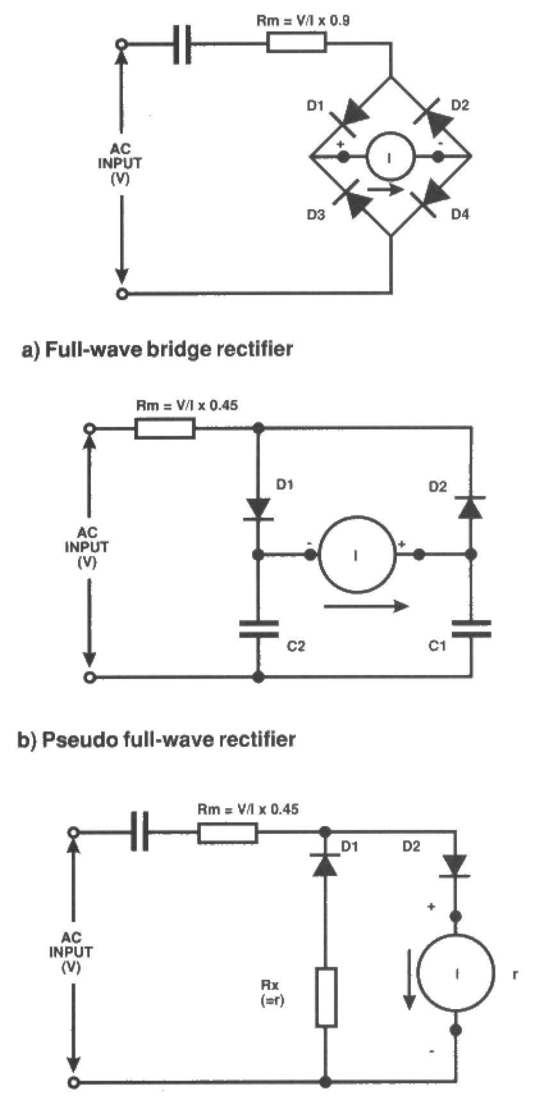
VFSD	R1
1V	10M
100mV	1M0
10mV	100k
1mV	10k

Fig.14 Practical DC millivoltmeter circuit.



V_{FSD}	R_1
10V	10M
1V	1M0
100mV	100k
10mV	10k
1mV	1k0

Fig.15 Volt/millivolt DC voltmeter converter.



a) Full-wave bridge rectifier

b) Pseudo full-wave rectifier

c) 'Ghosted' half-wave rectifier

Fig.16 These meter-driving rectifier circuits each have a symmetrical input impedance.

there is not the slighest difficulty in getting them to operate with an FSD frequency response that extends to tens or hundreds of MHz. Their major problem is that they have a very non-linear scale response at low voltages, and this is the major area where electronics can be used to enhance their performance.

To give a linear scale response, an AC meter's instantaneous current must be directly proportional to the instantaneous input voltage; in a conventional meter this action occurs

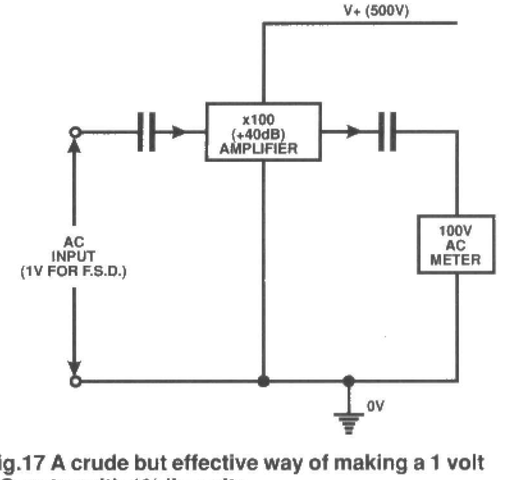


Fig.17 A crude but effective way of making a 1 volt AC meter with 1% linearity.

when Rm is very large relative to the rectifier's impedance and the input voltage is very large relative to the rectifier's forward volt drop. Typically, linearity is about 3% of FSD in a 10 volt meter, and about 1% in a 100 volt meter. Thus, one obvious way to make a highly linear meter with an FSD sensitivity of 1 volt is to connect the basic meter to read 100 volts FSD (to give the desired linearity) and then drive it via a x100 (= +40dB) amplifier, so that it reads FSD with an AC input of 1 volt, as shown in Figure 17.

The crude technique of Figure 17 has obvious drawbacks in terms of power supply requirements, but it does serve to illustrate the fundamental fact that a meter's scale response can be linearized with the aid of amplifier gain. Rough rules of thumb for the minimum required gain factors are as

follows:

GAIN FACTOR for 3% linearity = $10/V_{FSD}$
GAIN FACTOR for 1% linearity = $100/V_{FSD}$

Thus, to make a 100mV meter with 1% linearity, a gain of at least x1000, or 60dB, is needed. In reality, a far more practical way of using this gain to linearize a meter is to use it to subject the meter circuitry to negative feedback, as in the case of Figure 18, in which the basic meter is designed to read 1 volt FSD but is linearized by subjecting it to 40dB of negative feedback via the unity-gain input amplifier.

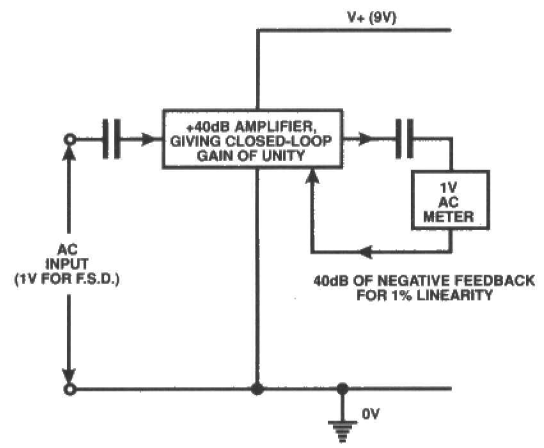


Fig.18 A more practical way of making a 1 volt AC meter with 1% linearity.

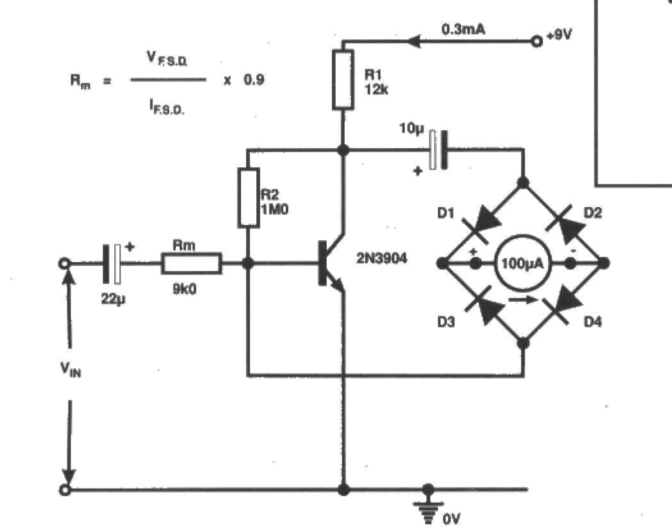


Fig.19 The frequency response of this 1 volt AC meter is flat to above 150kHz.

Transistor AC Meter Circuits

Figure 19 shows a practical example of a 1 volt FSD AC meter using the feedback linearizing technique on a bridge rectifier type of meter network. This simple circuit draws a quiescent current of about 0.3mA, has an FSD frequency response that is absolutely flat from below 15Hz to above 150kHz, and has 1% linearity up to 100 when using 1N4148 silicon diodes, or to above 150kHz when using BAT85 Schottky types. The R1 value of this circuit is chosen to give a quiescent current about three times greater than the meter's FSD value, to give the meter automatic overload protection.

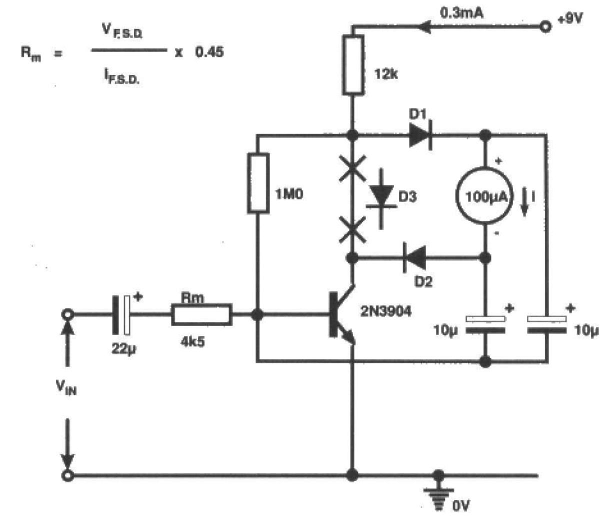


Fig.20 'Pseudo full-wave' version of the 1 volt AC meter.

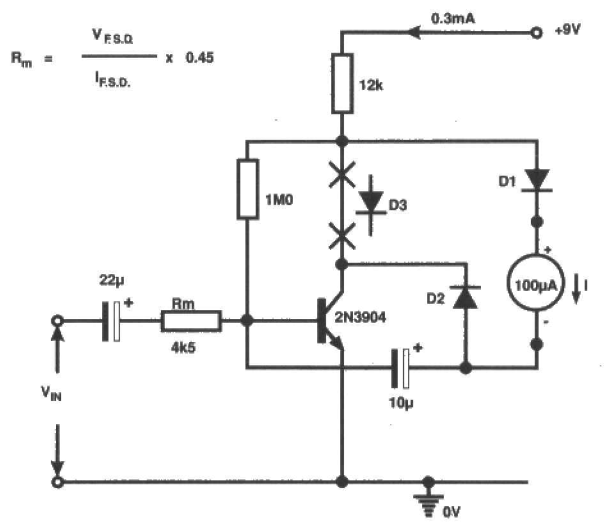


Fig.21 'Ghosted' half-wave version of the 1 volt AC meter.

Figures 20 and 21 show 'pseudo full-wave' and 'ghosted half-wave' versions of the above circuit. Note that diode D3 is sometimes used in these circuits to apply slight forward bias to D1 and D2 and thus help improve linearity, but this often causes the meter to pass a 'standing' current when no AC input is applied; this practice is thus not recommended.

The diodes used in these and all other electronic 'AC meter' circuits should normally be silicon (1N4148, etc.) types, or Schottky types if an exceptionally good performance is needed (because of the high sensitivity of these, the circuit may need screening, to exclude unwanted A.F. pick-up). Germanium diodes are generally not suitable for use in negative feedback circuits, due to their relatively low values of reverse impedance.

In the Figure 19 to 21 circuits the transistor is used in the common emitter mode; in this mode a single transistor's open-loop gain is rarely much greater than 40dB, so these circuits can not give a FSD input sensitivity greater than 1

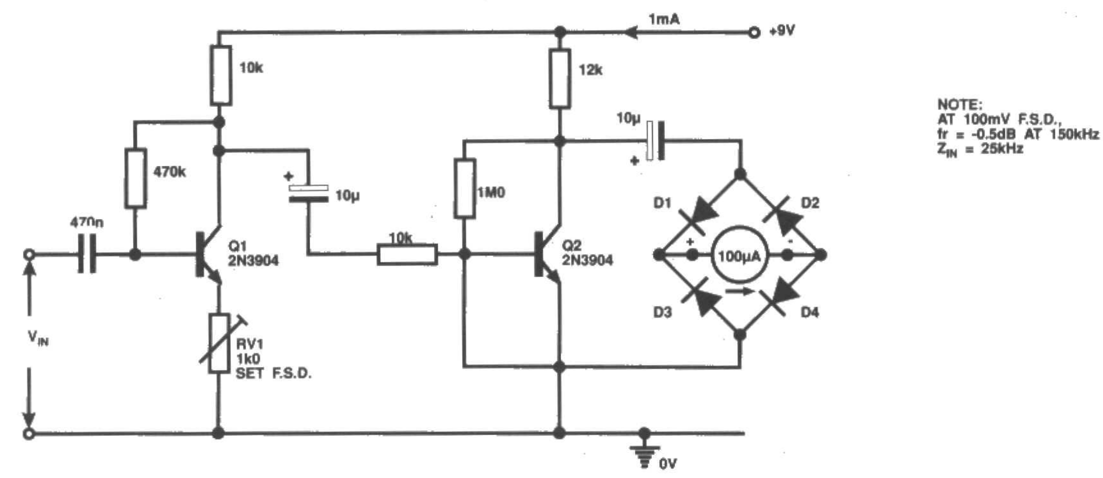


Fig.22 This AC voltmeter can be set to give FSD sensitivities in the range 20mV to 200mV.

volt without incurring a loss of meter linearity. Reduced sensitivity can be obtained by simply increasing the Rm value, e.g., by a factor of ten for 10 volts FSD, etc., (note in all cases that the circuit's input impedance equals the Rm value).

If greater FSD sensitivity is wanted from the above circuits it can be obtained by applying the input signal via a suitable preamplifier, i.e., via a +60dB amplifier for 1mV sensitivity, etc. Figure 22, for example, shows a simple way of modifying the Figure 19 circuit to make the FSD sensitivity variable between roughly 20mV and 200mV (via RV1) via a single additional common emitter amplifier stage. With the sensitivity set at 100mV FSD this circuit has an input impedance of 25k and a bandwidth that is flat within 0.5dB (about 5%) to 150kHz.

The second part of this mini-series looks at op-amp based AC volt/millivolt meter circuits, and at precision AC/DC voltage converters.

2 DiscoAmiga

Magnus Pihl continues with his computer controlled lightshow for the Amiga.

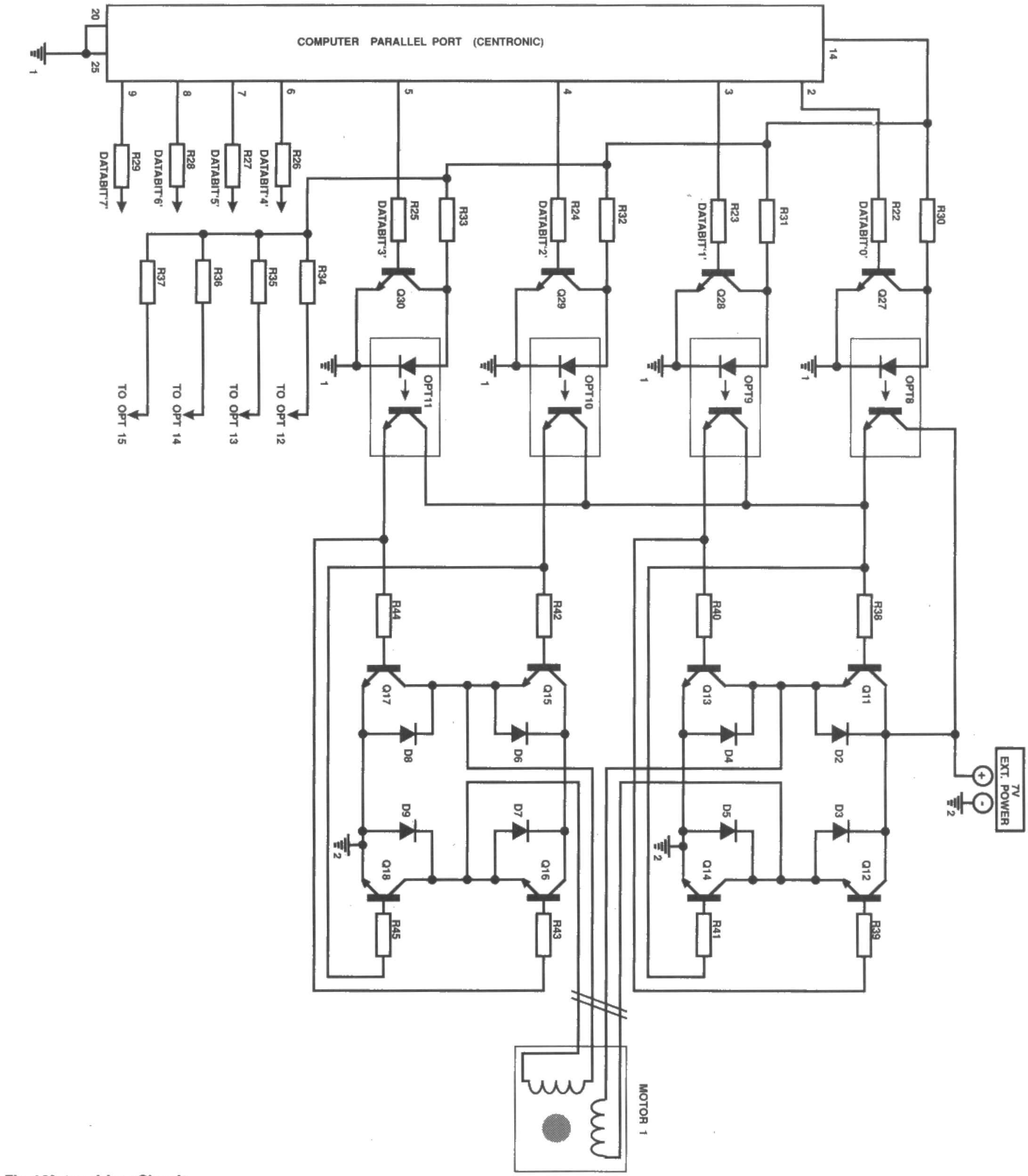


Fig.4 Motor-driver Circuit

We now move on to the construction. Fit both interfaces with their component parts. If you haven't got a stroboscope, you can buy Vellerman's K2601 and mount it inside an old bedroom lamp. Make sure the Xenon-tube doesn't reach the metallic reflector, as their is over 3000V inside that tube, and on the card so a short-circuit isn't the best thing you could do to it. Mount the strobe and spotlights in the desired positions. Be sure they are mounted safely, as there are high voltages around when the lamps are illuminated. Mounting the light units to the stepper motors can be easily carried out. Buy a 'U-bolt', and lock it against the rotating axis with the two nuts. Take an old pocketlamp and throw the handle away, so you only have the light dispenser with lens and reflector left. Paint the lens red or green (or in that colour you want) with a permanent overhead pen. Use stout wire and tape to fasten it to the axis and the U-bolt. Lamp cables should be of multi-strand type to withstand constant movement. Hide all cables in trunking and connect all cables to the connectors on the interfaces. The external voltage is taken from a laboratory power supply, a home-built stabilized power supply, or a ordinary power-supply bought from any electronic dealer. Be sure it can supply at least 2A. For those who want to build their own, wouldn't have any problem with the construction, so there is no reason to draw any schematics for that.

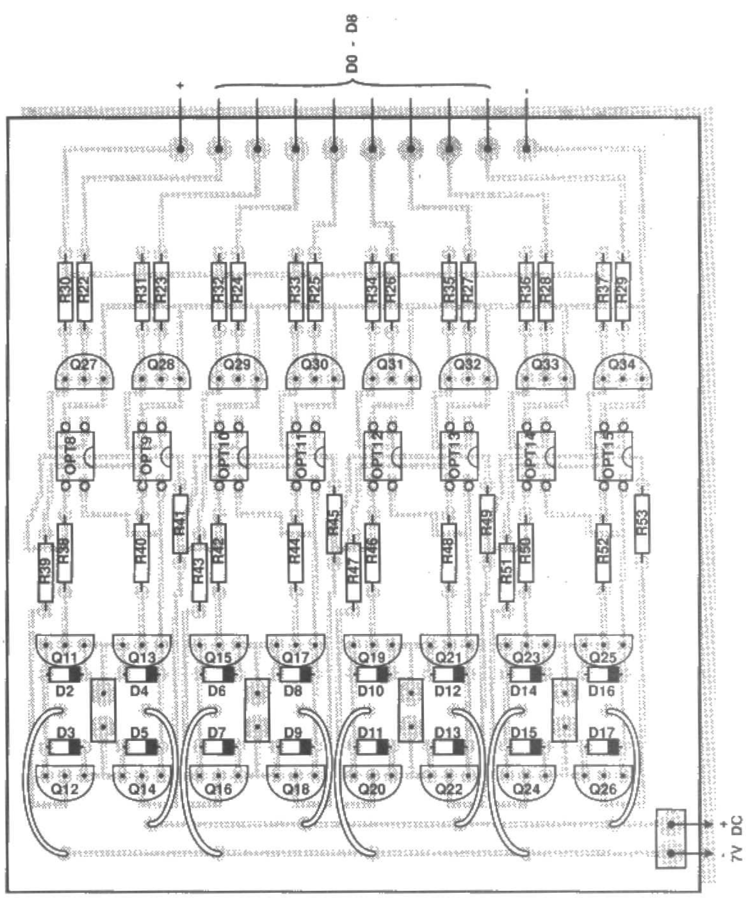


Fig.5 Motor-driver component overlay (Motor connections are shown between diodes)

The Special Parts.

Be sure that you are using bipolar (4 cables) motors with higher resistance than 38 ohm. Otherwise you'll need a higher current power supply and transistors. The motor must be so strong so it can rotate easily with a 80Nmm force. The lamps on the motor should be 7.2V, 500mA. Do not get any closer to 7V, otherwise you might be changing them all the time.

Spotlights: Use normal coloured 40W spotlights. Don't use higher wattage, even if the triacs can take over 3000W.

Remember that the triacs aren't coupled with any coil or capacitor, which might result in radio disturbances.

Testing and troubleshooting..

Make sure you've checked everything, so nothing is wrong. Plug in the 25-pin. DSUB connector in your computer and turn it on. If it doesn't start normally, or at all, immediately turn your computer off. The problem is somewhere before the optoswitches, if no connection is between both sides. If it operates as normal, then turn on the external power.

Initiate the interfaces and try to get any lamp to light. If all lamps are okay, then write the listed program into an Amiga assembler (Devpack is preferred) and run it, or write your own program using the "1/2 phase excitaion" diagram to test the motors. Don't think everything will run as you want immediately, it took me a month to develop this project with researching, building and programming.. Minor alterations might be carried out by changing the program. If you've got a laboratory power supply with a current-meter, you can easily see if current is passing through the motor. Normally the stepmotor axis can be moved easily without using any force, but when current is passing through one or both coils, you need to force it. An oscilloscope is preferred to find faults here. To test if the motor is working when not in the circuit is easy. Short-circuit the two leads from each coil. If it's harder to turn them,they probably are working well.

Progamming

The program listed is written in Devpack assembler for Amiga, but the hardware should work on any computer with a centronics port. For those who do not own an assembler, an Amigabasic test program is written here Good luck, and enjoy your lightshow!!

Initializing the interfaces

```
Amiga Assembler:  Move.b #255,$bfe301
                  Move.b #199,$bfd200
Amiga Basic:      Poke   &12575489,255
                  Poke   &12571136,199
```

Choosing a lamp.

```
Amiga Assembler:  Move.b #n,$bfd000
Amiga Basic:      Poke   #n,$12570624,n
```

Where 'n' is a number between 248-255.

PROJECT

Program list.

As told before, this is Amiga assembler written in Devpack...
Program: Left-Alt, then CTRL
Show: RETURN, then CTRL
HELP: Park motors and quit.
ESC: Drop motors and quit.

All data will be located in memory at $60000. If you want, you could save it and use it whenever you want.

```
        Move.b  #$ff,$bfe301      ; Stt datasignalerna till
                                    output
        Move.b  #199,$bfd200      ; Set ports to output.
        Move.b  #255,$bfe101      ; Zero databus.
        Move.b  #255,$bfd000      ; Turn off all lamps.
        Move.l  #0,d0             ; Clear registers.
        Move.l  #0,d1
        Move.l  #0,d2
        Move.l  #0,d3
        Move.l  #0,d4
        Move.l  #0,d6
        Move.l  #$60000,a2        ; Place to write data.
        Move.b  #0,$7f000 ; Status motor 1.
        Move.b  #0,$7f002 ; Status motor 2.
        Move.b  #1,$7f004 ; Programstatus.
        Lea     Hasta,a0 ; Motor1 data.
        Lea     Vista,a1 ; Motor2 data.
        Bra.s   Choose

Motor1  ds.l    0       ; Positionsdata motor1.
Motor2  ds.l    0       ; Positionsdata motor2.
Status  ds.b    1       ; Programstatus.
Value   ds.l    1
Area    Equ     $60000

Choose  Cmp.b   #$37,$bfec01      ; Programming = Left-Alt.
        Beq.s   Prog
        Cmp.b   #$77,$bfec01      ; Discoshow = Right-Alt.
        Beq.w   XL
                Bra.w   Choose
XL      Bsr.s   CTRL
                Bra.s   DShow

        **********************************
        **********************************
        ***                            ***

Prog    Btst    #14,$dff002       ; Fast clearing of
                                    programmemory.
        Bne.s   Prog
        Move.l  #Area,$dff054
        Move.w  #0,$dff066
        Move.l  #$01000000,$dff040
        Move.w  #64*900+20,$dff058
        Bsr.s   CTRL
        Bra.w   Main

CTRL    Cmp.b   #$39,$bfec01      ; Wait for startcommand = CTRL.
        Bne.s   CTRL                (Music synchronisation)
        Rts

DShow   Move.l  #$100,d5 ; Timer
        Move.b  #0,Value
        Cmp.b   #$41,$bfec01      ; HELP, Park motors, quit.
        Beq.w   OutF
        Cmp.b   #$75,$bfec01      ; ESC, Drop motors, quit.
        Beq.w   OutQ
DShowi  Sub.l   #1,d5
        Cmp.l   #0,d5
        Bne.s   DShowi
        Move.b  (a2),Value
        Move.b  #0,Status
        Bra.s   Check1
DShowj  Move.b  #255,$bfd000
        Add.l   #1,a2
        Bra.s   DShow

Check1  Cmp.b   #$41,Value        ; HELP, Park motors, quit.
        Beq.w   OutF
        Cmp.b   #$75,Value        ; ESC, Drop motores, quit.
        Beq.w   OutQ
        Cmp.b   #$5f,Value        ; Rotating lights.
        Beq.w   Motors
        Cmp.b   #$5d,Value        ; Spot1
        Beq.w   SP11
        Cmp.b   #$5b,Value        ; Spot2
        Beq.w   SP21
        Cmp.b   #$59,Value        ; Stroboscope.
        Beq.w   Flash1
        Cmp.b   #1,Status
        Beq.s   DShowj
        Move.b  #1,Status
        Bra.w   DShowj

Main    Move.l  #$100,d5 ; Timer
        Move.b  #0,Value
        Cmp.b   #$41,$bfec01      ; HELP, Park motors, quit.
        Beq.w   OutF
        Cmp.b   #$75,$bfec01      ; ESC, Drop motors, quit.
        Beq.w   OutQ
Maini   Sub.l   #1,d5             ; Syncronisize.
        Cmp.l   #0,d5
        Bne.s   Maini
        Move.b  $bfec01,Value     ; Check keyboard.
        Move.b  #0,Status
        Bra.s   Check             ; SHOW!
Back2   Move.b  #255,$bfd000      ; Turn off all lamps.
        Add.l   #1,a2             ; Increase in memorylist.
        Bra.s   Main

Check   Cmp.b   #$41,Value        ; HELP, Park motors, quit.
        Beq.w   OutF
        Cmp.b   #$75,Value        ; ESC, Drop motors, quit.
        Beq.w   OutQ
        Cmp.b   #$5f,Value        ; Rotating lights.
        Beq.s   Motors
        Cmp.b   #$5d,Value        ; Spot1
        Beq.w   SP1
        Cmp.b   #$5b,Value        ; Spot2
        Beq.w   SP2
        Cmp.b   #$59,Value        ; Stroboscope.
        Beq.w   Flash
Backh   Bra.s   Back2
Back3   Move.b  Value,(a2)        ; Write value.
        Bra.s   Back2

Motors  Move.b  (a0)+,d0 ; Get motor 1 data.
        Move.b  (a0)+,d1
        Move.b  (a1)+,d2 ; Get motor 2 data.
        Move.b  (a1)+,d3
        Bra.s   LoopX

Start   Lea     Hasta,a0 ; New list motor1.
        Lea     Vista,a1 ; New list motor2.
        jmp     $fc0000

LoopX   Cmp.b   #0,d0             ; Check if list is empty.
        Beq.w   Start
        Cmp.b   #0,d2
        Beq.w   Start
        Move.b  #250,$bfd000      ; Turn on lamp 1.
        Cmp.b   #5,d0
        Beq.w   O
        Cmp.b   #6,d0
        Beq.w   Q
TBax    Dbf     d1,LoopX
TBaz    Move.b  #254,$bfd000      ; Turn on lamp 2.
        Cmp.b   #5,d2
        Beq.w   OX
        Cmp.b   #6,d2
        Beq.w   QX
Back    Dbf     d3,TBaz
        Move.l  #0,d0
        Move.l  #0,d1
        Move.l  #0,d2
        Move.l  #0,d3
        Bra.w   Back2

O       Sub.b   #1,$7f000 ; Count steps.
        Move.b  #9+16,$bfe101
        Bsr.w   Loop
        Move.b  #8+16,$bfe101
        Bsr.w   Loop
        Move.b  #10+16,$bfe101
        Bsr.w   Loop
        Move.b  #2+16,$bfe101
        Bsr.w   Loop
        Move.b  #6+16,$bfe101
        Bsr.w   Loop
        Move.b  #4+16,$bfe101
        Bsr.w   Loop
        Move.b  #5+16,$bfe101
        Bsr.w   Loop
        Move.b  #1+16,$bfe101
        Cmp.b   #0,$7f004 ; Check with status where to
                  go next.
        Bne.w   TBax
        Bra.w   Out
OX      Sub.b   #1,$7f002
```

```
        Move.b  #144+1,$bfe101
        Bsr.w   Loop
        Move.b  #128+1,$bfe101
        Bsr.w   Loop
        Move.b  #160+1,$bfe101
        Bsr.w   Loop
        Move.b  #32+1,$bfe101
        Bsr.w   Loop
        Move.b  #96+1,$bfe101
        Bsr.w   Loop
        Move.b  #64+1,$bfe101
        Bsr.w   Loop
        Move.b  #80+1,$bfe101
        Bsr.w   Loop
        Move.b  #16+1,$bfe101
        Bsr.w   Loop
        Cmp.b   #0,$7f004
        Bne.w   Back
        Bra.w   Cnt1

Q       Add.b   #1,$7f000
        Move.b  #1+16,$bfe101
        Bsr.w   Loop
        Move.b  #5+16,$bfe101
        Bsr.w   Loop
        Move.b  #4+16,$bfe101
        Bsr.w   Loop
        Move.b  #6+16,$bfe101
        Bsr.w   Loop
        Move.b  #2+16,$bfe101
        Bsr.w   Loop
        Move.b  #10+16,$bfe101
        Bsr.w   Loop
        Move.b  #8+16,$bfe101
        Bsr.w   Loop
        Move.b  #9+16,$bfe101
        Bsr.w   Loop
        Bra.w   TBax

QX      Add.b   #1,$7f002
        Move.b  #16+1,$bfe101
        Bsr.w   Loop
        Move.b  #80+1,$bfe101
        Bsr.w   Loop
        Move.b  #64+1,$bfe101
        Bsr.w   Loop
        Move.b  #96+1,$bfe101
        Bsr.w   Loop
        Move.b  #32+1,$bfe101
        Bsr.w   Loop
        Move.b  #160+1,$bfe101
        Bsr.w   Loop
        Move.b  #128+1,$bfe101
        Bsr.w   Loop
        Move.b  #144+1,$bfe101
        Bsr.w   Loop
        Bra.w   Back

SP1     Move.l  #$1a00,d5 ; Turn on SPOT 1.
        Move.b  #248,$bfd000
BP1     Sub.l   #1,d5
        Cmp.l   #0,d5
        Bne.s   BP1
        Bra.w   Back3

SP2     Move.l  #$1a00,d5 ; Turn on SPOT 2.
        Move.b  #252,$bfd000
BP2     Sub.l   #1,d5
        Cmp.l   #0,d5
        Bne.s   BP2
        Bra.w   Back3

Flash   Move.l  #$1a00,d5 ; Use stroboscope.
        Move.b  #249,$bfd000
FL1     Sub.l   #1,d5
        Cmp.l   #0,d5
        Bne.s   FL1
        Bra.w   Back3

SP11    Move.l  #$1a00,d5 ; Turn on SPOT 1.
        Move.b  #248,$bfd000
BP11    Sub.l   #1,d5
        Cmp.l   #0,d5
        Bne.s   BP11
        Bra.w   DShowj

SP21    Move.l  #$1a00,d5 ; Turn on SPOT 2.
        Move.b  #252,$bfd000
BP21    Sub.l   #1,d5
        Cmp.l   #0,d5
        Bne.s   BP21
        Bra.w   DShowj

Flash1  Move.l  #$1a00,d5 ; Use stroboscope.
        Move.b  #249,$bfd000
FL11    Sub.l   #1,d5
        Cmp.l   #0,d5
        Bne.s   FL11
        Bra.w   DShowj

OutQ    Move.b  #255,$bfe101
        Move.b  #255,$bfd000
        Move.b  Value,(a2)
        Rts

OutF    Move.b  Value,(a2)
        Move.b  #0,$7f004 ; Park motors.
Out     Cmp.b   #0,$7f000
        Beq.s   Cnt1
        Bchg    #1,$bfe001
        Bsr.w   Q
Cnt1    Cmp.b   #0,$7f002
        Beq.s   Cnt2
        Bsr.w   QX
Cnt2    Move.b  #255,$bfe101
        Rts

Loop    Move.l  #$a00,d5 ;  Step/timecycle
Loop2   Dbf     d5,Loop2
        Rts

Hasta   Dc.b    6,30,5,10,6,15,6,5,5,15,5,10,6,15,6,10,5,40
        Dc.b    6,40,5,30,6,40,5,20,6,15,5,45
        Dc.b    6,50,5,5,5,5,5,5,6,5,5,10,5,10,6,5,5,25
        Dc.b    6,5,6,5,6,5,6,15,5,5,6,5,6,5,6,5,5,40
        Dc.b    5,50,6,50,5,10,6,5,5,15,6,20,5,25,6,25,
                0,0,0,0
Vista   Dc.b    6,50,5,5,5,5,5,5,6,5,5,10,5,10,6,5,5,25
        Dc.b    6,5,6,5,6,5,6,15,5,5,6,5,6,5,6,5,5.40
        Dc.b    5,50,6,50,5,10,6,5,5,15,6,20,5,25,6,25
        Dc.b    6,30,5,10,6,15,6,5,5,15,5,10,6,15,6,10,5,40
        Dc.b    6,40,5,30,6,40,5,20,6,15,5,45,0,0,0,0
```

		1-Phase exitation				2-Phase exitation				1-2 Phase exitation							
SHIFT No.		1	2	3	4	1	2	3	4	1	2	3	4	5	6	7	8
MOTOR	COIL2	+		-		+	+	-	-	+	+	+		-	-	-	
		-		+		-	-	+	+	-	-	-		+	+	+	
	COIL1		+		-	-	+	+	-	-		+	+	+		-	-
			-		+	+	-	-	+	+		-	-	-		+	+

Fig.6 Table of excitation polarity for the motors

PARTS LIST

(Note this list replaces any quoted list last month)

RESISITORS

R1,4,7,10,13,16,19,30-37 330R
R2,3,5,6,8,9,11,14,17,20,22-29 10k
R12,15,18,21,38-53 4k7

CAPACITORS

C1 100nF/16V

SEMICONDUCTORS

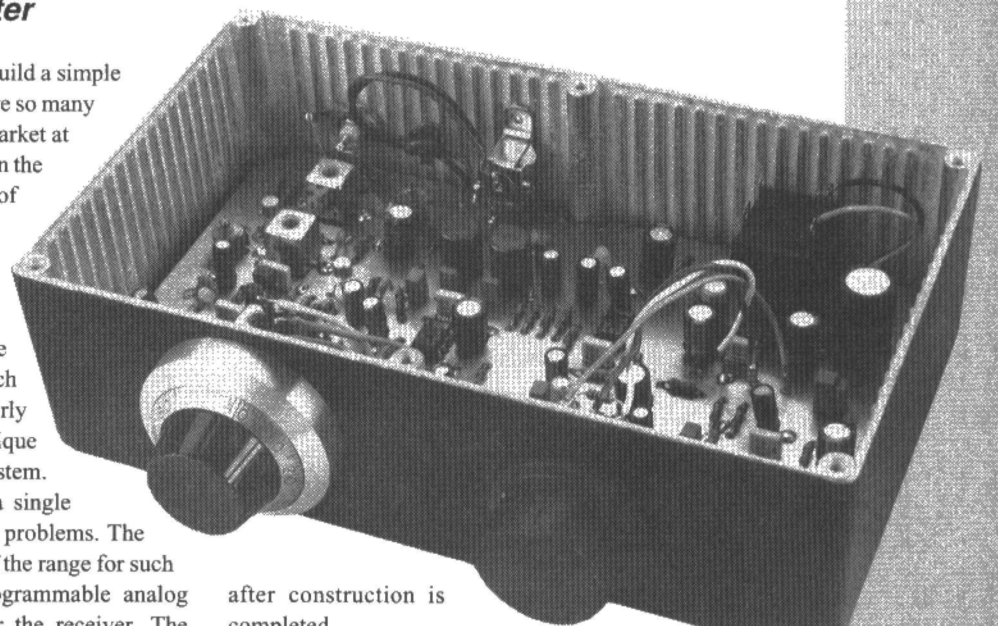
IC1 74LS42
Q1,3,5,7,8,9,10,27-34 BC546B
Q2,4,6 BD683
Q11-26 BC337-25
TR1-4 TIC225D
OPT1-3,8-15 PC715
OPT4-7 MOC3021
D1-17 1N4003

MISCELLANEOUS

RLY1Relay 6V 500V-0.5A contacts MZP A001 4205
K1 25pin DSUB male
Case to K1
Suitable connections to outputs
13way cable
Plastic case to mount the card in. (with cooling)

Direct Conversion Receiver with AGC

by David Silvester



Why should anyone want to build a simple radio receiver when there are so many excellent products on the market at the present time. For those in the know the answer is simple, the joy of hearing voices out of thin air on a receiver you have built yourself is vastly greater than that achieved whilst listening to a purchased commercial receiver. There is adequate evidence of this in the popularity of such receiver projects. Such home built receivers are of necessity fairly simple using the direct conversion technique rather than the complicated superhet system. Equally they tend to be restricted to a single amateur band to ease the RF alignment problems. The project in this case is probably the top of the range for such a simple receiver since it uses a programmable analog compandor to provide audio AGC for the receiver. The reason for going to such lengths reveals itself in the comparison of this receiver with others without the AGC. If you are tuning across the band with the radio set up to listen for low level signal then sooner or later you will hit a high level signal. The effect without AGC is very painful on the ears the authour having resorted to ripping off the headphones to stop the pain. AGC gets over that difficulty but the receiver becomes more complicated and ends up with 144 components on the single PCB which some may feel takes it out of the simple receiver bracket. The radio is however easy to construct and tune since there are few adjustments to make after construction is completed.

The components list given is for the authors favourite listening band of 20 metres (14.0 to 14.35MHz). When considering the amateur bands 20 metres is just about the upper frequency limit that direct conversion receivers can be used on, as above this drift and pickup problems become tricky to overcome. Above 20 metres the option of a converter prior to a lower frequency receiver becomes the best option. This band can be reasonably guaranteed to have something of interest going on at all times of the day and night. The circuit can be retuned for other bands and this is covered later in the text.

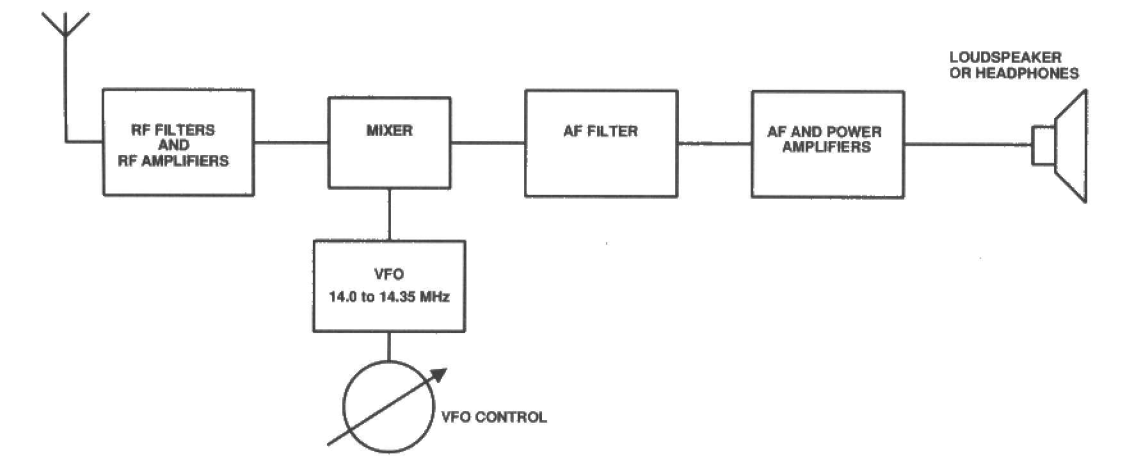


Fig.1 Block diagram

Circuit Operation

I hope that readers familiar with the direct conversion technique will forgive me for including the information in the next few paragraphs although they explain some of the effects found in the receiver and may be of interest.

Consider the block diagram of the direct conversion receiver shown as Figure 1. The signal from the antenna passes to the RF filter circuit directly. This is a tuned coil that selects the 20 metres band and provides the impedance change to convert the antenna input of 50R to that required by the RF amplifier. The RF amp stage is not just to provide gain. It must be remembered that the variable frequency oscillator (VFO) and the RF filter all work at the same frequency. With high levels of signal from the VFO it is possible that the mixer could pass some of this back to the antenna where it will be radiated, since the RF filter cannot block it's passage. The RF amp whilst giving a small gain in the forward direction, ie into the mixer, has a much more important job of preventing the feedback of the VFO signal into the antenna.

The mixer has two input signals the amplified antenna input covering the 20 metre band and the single stable frequency from the VFO. In the mixer the difference signal is generated along with many others and this difference signal consists of an audio band which is removed by the AF filter for further amplification. The other frequencies are all rejected. The final stage is a high gain AF amplifier which in this design has audio AGC (Audio Gain Control) and a power amplifier to drive a set of headphones or a small loudspeaker. The author prefers headphones as it stops the family being driven mad with the odd noises that SSB reception produces.

To examine the direct conversion technique for the reception of SSB let us look at an incoming upper sideband signal that would have had a 14.200MHz carrier if this were not removed prior to transmission, see Figure 2a. The incoming audio is normally filtered to give a set of frequencies from 300 to 3000Hz, this range providing sufficient bandwidth for intelligibility. In the transmit mixer the modulation of the carrier at 14.2MHz generates a number of possible outputs depending on how the mixer system is configured. The simplest gives an output that consists of two sidebands and some carrier. This is the AM of the medium waveband. However AM is inefficient and other mixer types can eliminate the carrier leaving only the two sidebands, which although better than AM still uses extra bandwidth. In fact the two sidebands both contain all of the message information and it is only necessary to transmit one, which is done in SSB.

In the direct conversion receiver we mix the single sideband signal frequencies that have been transmitted with a stable 14.200MHz provided by the VFO, Figure 3a. In the receive mixer the sum and difference frequencies are generated and the difference, which is an audio signal is filtered out from the rest. The principals of reception are also true for lower sideband and CW signals. The signal will still be resolved if the VFO is very slightly offset from the correct

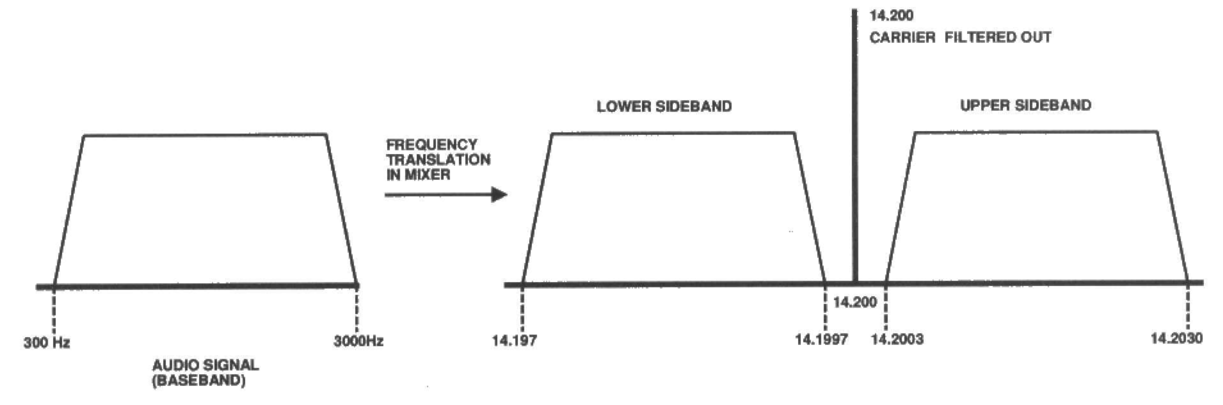


Fig.2 Double sideband production in the mixer

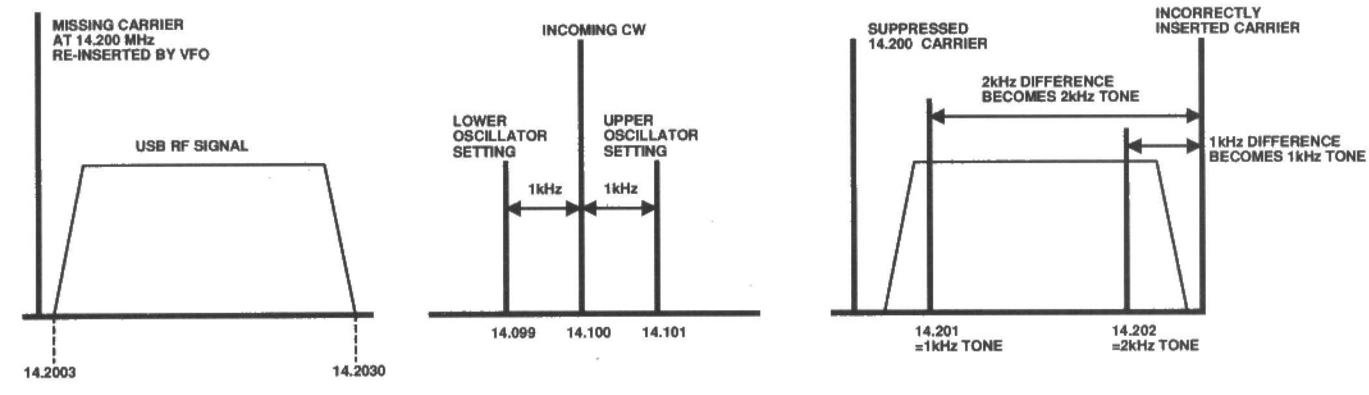


Fig.3 Sideband graphical information

PROJECT

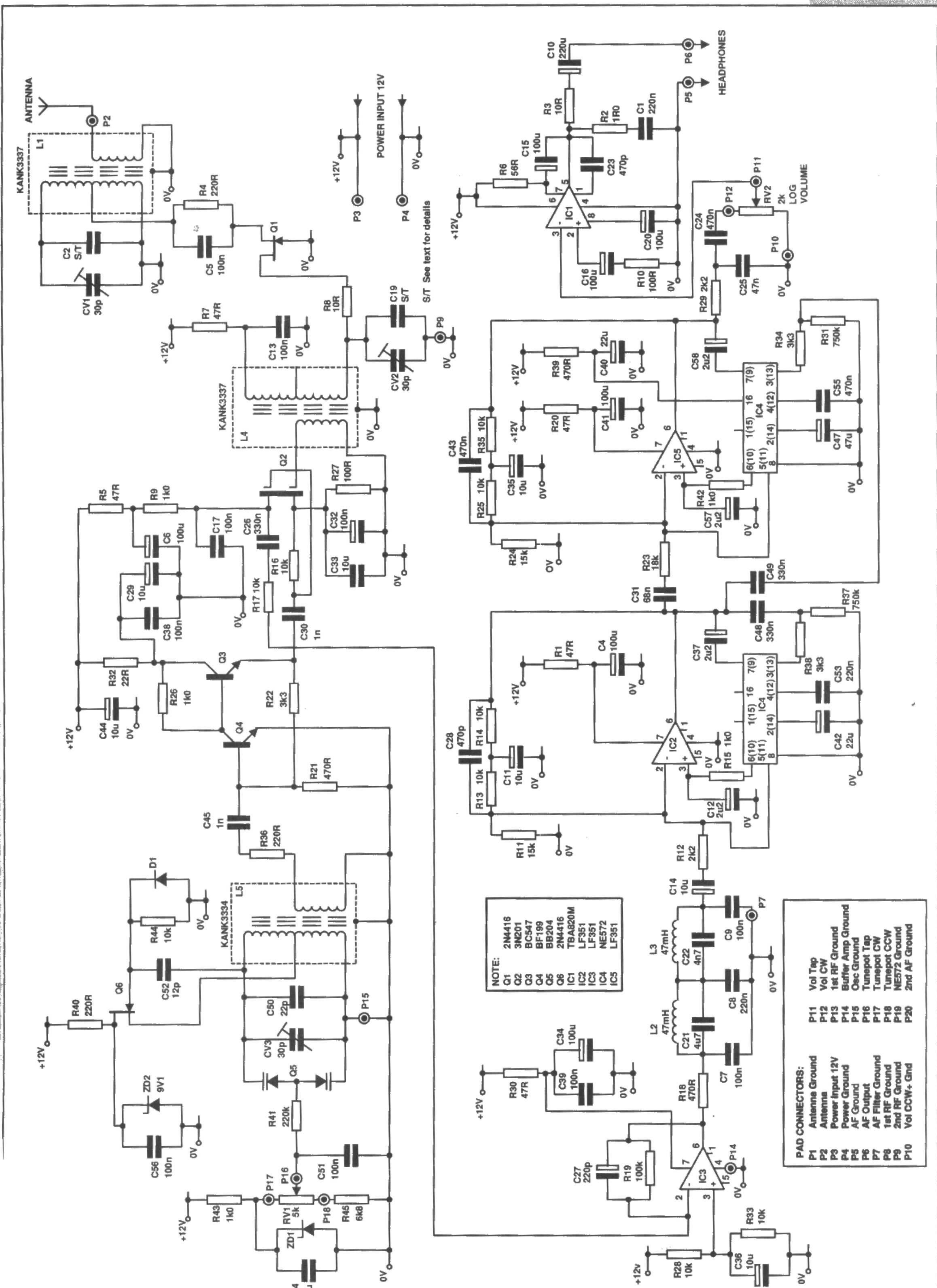


Fig.4 Complete circuit diagram

How it Works

Figure 4 shows the full working circuit. In this drawing the numbering for the components is taken from the PCB layout after completion and also after renumbering from top left to bottom right. Hence the numbers on the schematic are not sequential. The circuit around Q6 is a Hartley oscillator based on a purchased coil. Q5, the BB204 is a dual varicap diode that allows the oscillator to tune the 20 metre band. Control voltage for the varicap comes from a ten turn potentiometer as this provides the necessary slow tuning needed for SSB reception and allows a numerical turn indicator to be fitted that can be calibrated for frequency. Zener diodes ZD1 and ZD2 provide voltage stabilisation for the oscillator itself whilst D1 provides negative feedback for the oscillator output voltage to maintain this at a stable level. A 2N4416 device has been chosen for use here as it has a much closer tolerance for it's Idss parameter and this makes for a more reproducible output level. In addition the case is grounded via one of the pins and this makes the circuit less sensitive to extraneous capacitances within the radio's case. Other RF FET devices can be used such as the BF245B as this has a closely controlled Idss, whilst MPF102 or 2SK55 will also work with more variable output levels. The circuit around Q3 and Q4 provides the gain to give about 5V peak to peak at the mixer gate 2 input. This circuit has been used by the author on a number of occasions and has proved to be stable and easy to reproduce. One interesting change that was taken to increase the stability of the circuit is that the ferrite threaded adjuster fitted to the coil has been completely removed. It was found that this ferrite was causing the largest part of the long term drift that was experienced in the oscillator circuit. Lowering the inductance in such a manner required a corresponding increase in the capacitance of the circuit to maintain the same frequency.

The RF input has L1 as the tuned input RF filter, with C3 as the tuning capacitor. There is space for another paralled tuning capacitor C2 included on the circuit but in the case of the 20 metre receiver this is not fitted. A place has been made for it on the PCB for use when the receiver has been modified to tune to other frequency bands. Q1 is a grounded gate RF amplifier with R4 stabilising the DC current in the device whilst C5 allows the RF signal to pass un-attenuated. R8 is added to the circuit to add RF stability as on occasions the grounded gate FET circuit has been known to develop self oscillation to the detriment of it's operation as an amplifier. L4 is the RF impedance conversion to the mixer gate 1 input and a second stage of band filtering.

The mixer circuit uses a common dual gate FET as the active element. The AF signal passes away to the AF amplifier through C26 whilst the RF shorts to ground through C17. The AF signal passes to the first AF amplifier/buffer of IC3. This IC has a low gain (10 times) and a frequency response tailored by C27 to cut off high frequency AF signals that may result from close SSB signals. The rate of cut-off given by C27 is not high but sufficient to prevent interference problems. The main purpose of this part of the circuit is to provide the buffering for the AF passive filter around L2 and L3. For correct operation this requires to be fed by an input impedance of 470 ohms which the mixer cannot provide. Given that input impedances and operating into a 2k load the AF filter circuit gives a very sharp cut off of AF at 3kHz which selects a separate SSB signal from that directly above and below it in the RF band.

To prevent feedback through the power supplies affecting any two stages of the radio each section has it's own separate resistor/ capacitor power input filter. Equally separate low noise op-amps provide the AF gain rather than a single package containing all of the amplifiers.

Next comes the main audio amplifier with it's AGC circuit. Consider for a moment the circuit of Figure 5a. This is the standard inverting op-amp circuit with Ra providing the input impedance and Rb the feedback, the resistors for the non-inverting input have been left out for clarity. Ra can be AC coupled via a capacitor as no DC signal needs to pass through it, the DC current for the operation of the amplifier's input device comes via Rb. The circuit gain is Rb/Ra. If Rb is shorted by a capacitor as it is in IC3 (R19-C27) then the gain becomes frequency dependant cutting off at 6dB per octave from the point that the impedance of C27 equals the value of R19.

Now move on to Figure 5b. In this case Ra is the same as before but Rb is split into two separate halves Rc and Rd. Although Rc and Rd provide the op-amp's DC input current requirement it can have no effect on the gain of the circuit at AF as the centre point is AC shorted to ground by the capacitor Ca. The gain of the circuit is now controlled by impedance X. Returning to the main circuit diagram you can see that in the first AGC stage X consists of the parallel influence of C28 and the circuitry between IC4's pins 7 and 5. Capacitor C37 is a DC block to prevent incorrect operation of IC4. IC4 contains a variable resistor whose value is controlled by the AC signal on pin3. The rate of change of value of this variable resistor can be altered by capacitors C42 and C53. In this design they allow the variable resistors value to decrease rapidly (the attack phase) and increase slowly (the decay phase). Thus if the SSB signals level increases rapidly the stage gain will drop rapidly to compensate maintaining a constant output. When the SSB signal level drops then the stage gain will slowly increase again. In fact the AGC amplifier meeds two such stages to provide the AGC characteristics that the radio needs. The circuit was first seen in an article written by DF4SQ and published in Sprat, the GQRP club magazine in autumn 1991.

The final stage is an audio power amplifier based on the TBA820M chip, about which little needs to be said.

frequency of 14.200MHz, but the audio tone will be higher or lower depending on the offset error. Consider the situation with a CW signal shown in Fig3b. If the incoming signal is at 14.100MHz then the VFO set at either 14.099 or 14.101MHz, both differing from the incoming signal by 1kHz will resolve the CW as a 1kHz tone. Now when tuning up the CW section of the band with a direct conversion receiver the CW signal will appear twice. This is a major problem with the direct conversion receiver, but remember this is a receiver costing tens of pounds not a communications receiver costing best part of £1000.

With a single sideband signal an interesting effect occurs. Figure 3c shows our upper sideband signal with the missing carrier at 14.200MHz. As earlier if the VFO is at 14.200MHz then a normal audio signal is heard, but suppose the VFO is at 14.203MHz. In this case the original USB signal is treated as a lower sideband signal and the audio frequencies are inverted. Consider two tones in the original voice signal and let them be say 1kHz and 2kHz. After SSB conversion they will be transmitted as 14.201 and 14.202MHz respectively.

If now at reception the VFO is at 14.203MHz then the mixer and AF filter select the differences as the audio tones and the 14.202MHz incoming signal gets resolved as a 1kHz tone whilst it was a 2kHz tone in the original voice signal.

Construction

Construction of the radio is simple since all but the two potentiometers are mounted on the single PCB, see Figure 6. There is however a method of construction that is recommended due to the closeness of the parts in some areas. When ordering the components you will need to look at the parts list rather carefully since the pin spacing of the leads affects the suitability for use on the PCB. Consider capacitor C14: It has the symbol name of RE0.1 which refers to a radial electrolytic capacitor with a pin space of 0.1 inch. Thus providing the voltage exceeds 12V any radial electrolytic of 10μ will work for C14 but choose too high a voltage rating and the pin spacing increases to 0.15 inch and the capacitor will no longer fit. Thus the manufacturer symbol name refers to the pin space in inches, whilst the following letter 'G' signifies that one wire from the item (the negative lead in the case of electrolytic capacitors) is attached to the upper groundplane. Thus when ordering there is no difference between a RE0.1 and a RE0.1G the difference occurs when soldering to the PCB.

Construction should start with the through board pin

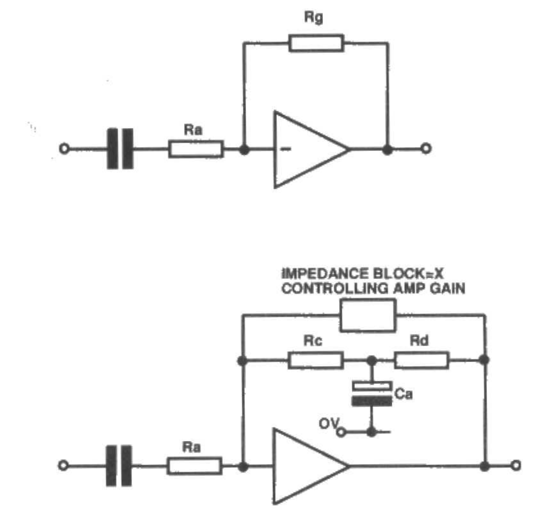


Fig.5

connections. The PCB uses a double sided construction with the upper surface used as a solid groundplane. If you have purchased a ready made board this should have rings etched around many of the holes where the component is not designed to connect to the groundplane. However there are 12 which do not have these rings they are the ground connections to the lower tracked layer. Connections P1, P4, P5 and P10 use 1mm PCB pins (Maplin Part FL23A) that are soldered to both the lower pad and the upper groundplane, and later provide a place to attach the off board ground wires. P7, P8, P9, P13, P14, P15, P19 and P20 are short through PCB pins (Maplin Part FL82D) that just connect the groundplane to a lower track in places where soldering to the upper layer directly is difficult. P2, P3, P6, P11, P12, P16 ,P17, P18 are the remaining 1mm PCB pins for off board connections that will have holes in the groundplane around them and are only soldered to the lower tracked layer.

The construction of the rest of the PCB is easy providing care is taken. The thick lines protruding from some of the components shown in Figure 6 are those soldered to the upper groundplane. To do this successfully you will need a medium power soldering iron as the groundplane sinks heat effectively and it is easy to make a faulty dry joint which will stop the receiver in its tracks. In the case of the inductors L1, L4 and L5 the case tabs are bent outwards and soldered to ground after the other connections have been made. It is probably easier to work either from one side of the PCB to the other or from the centre outwards rather than say fit all of the capacitors first as this will lead to difficulty in making some of the groundplane connections. Fig7 shows the way the leads were bent in the prototype. There are three large holes for the PCB supports into which clip in supports are pushed. These hold the board away from the metal of the case used in the final stage.

After completion of the PCB it can be tested by making rough connections to the board and listening for an incoming signal. Prior to powering up remove the ferrite core of L5 and set C46 to about half capacitance. You may need to twist the adjustments of C3 and C18 for a reasonable signal but it will not be necessary to move the ferrite adjusters in L1 and L4. If all is satisfactory at this stage than the final part of fitting the radio into it's case can begin. The PCB has been made as a close fit into a standard diecast aluminium box. It is merely necessary to drill the box to accommodate the 10 turn pot and it's indicator knob, the AF log pot and the holes for the RF, power and AF connectors. If the box is not pre-painted then this may be done next. Once dry the main PCB is stuck into

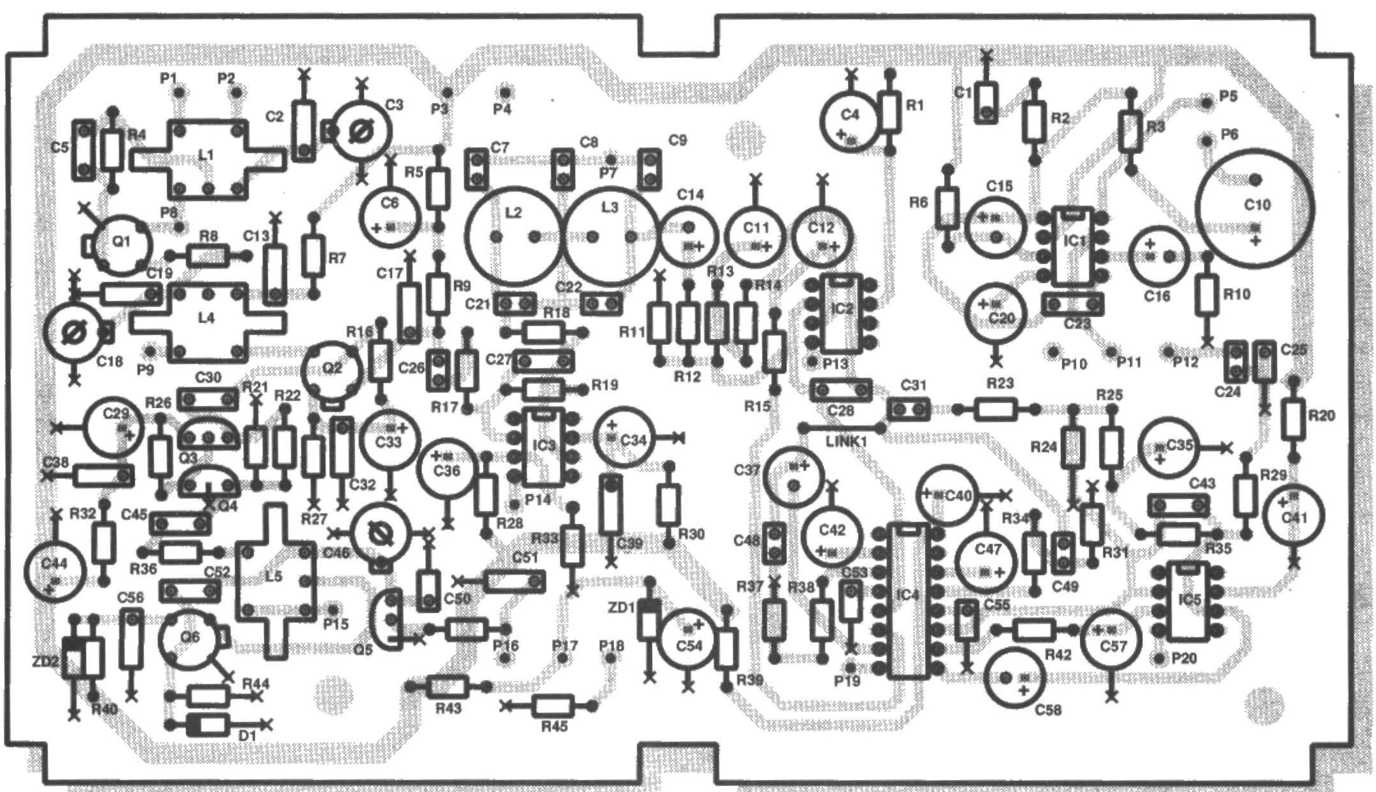


Fig.6 Component overlay (crosses indicate ground plane connections)

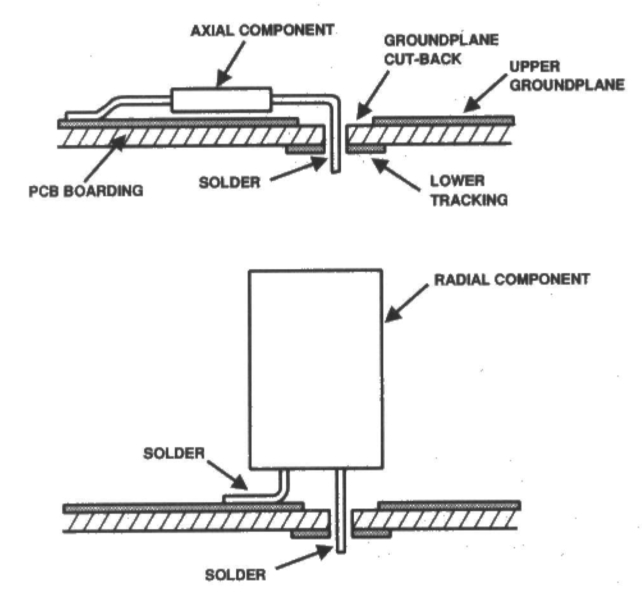


Fig.7 Groundplane clearance and soldered connections

the box with spots of glue on the PCB supports. Then fit the connectors and pots. Lastly solder all of the connections to the off board components.

Alignment

The setting up of the radio is very easy especially if you have access to a frequency counter. Connect the counter to gate 2 of Q2 and set the the ten turn pot fully clockwise, which should give the highest frequency. By adjusting C46 set this higher frequency to 14.35MHz. If you check the other end of the ten turn pot's range this should be 14.0MHz. Due to component variability a very small portion of the range may not be covered. The alternatives are to reduce the value of R45 or ignore the part of the band not of interest, possibly the lowest part of the CW band or the highest of the SSB section that tends to be less used.

Without a frequency counter the set-up technique becomes trickier. It is possible just to accept the range that you have with C46 set at the midpoint. The 20 metre band is fairly obvious due to the CQ calls put out by the amateurs on SSB and above and below this there are bands of CW signals which mark the edges. With a frequency marker received signals will indicate the 14MHz point then the 100kHz above this to calibrate the ten turn pot.

Antenna Erection

The antenna required by the receiver is connected to the receiver by a standard 50R screened coax BNC connector. The antenna itself is most likely to be a simple dipole and although this has a 75R characteristic impedance the match to the receiver will not suffer to any great extent. The simple dipole consists of two 16ft 11inch wire elements. One end of each is connected to an egg insulator and to a thin rope to allow attachment to a pulley mounted on the house wall and to the garden fence at the far end. In the centre is an insulating piece of plastic that holds the wires and allows connection of the downlead, which is a section of 75R twin downlead, NOT COAX. Inside the house is a home made balun unit connecting to the receiver via a length of 50R coax. Living on the south coast it was easy to get the rope from a local yacht chandlery and the insulators, wire and central adaptor came from a local Ham Radio store. The design for the balun and the antenna can be found in most of the Ham Radio books (HF Antennas for all Locations by L. A. Moxon G6XN is recommended) whilst the balun core is made from any small ferrite core mine being 0.8 OD by 0.25 ID by 0.25 high.

Modifications

As I have said earlier it is possible to tune the receiver to many other bands by resetting the tuned circuits. This will involve changes to the capacitance values of C46, C19, and C2 which was the reason for including the positions for these components although in the 20 metres receiver C2 and C19 are not used. The author can only recommend alteration to the other amateur bands since these have most of the SSB activity that it is legal to listen to. AM signals can be resolved but the carrier causes whistle problems if it is even slightly off tune. This design when compared to earlier project is much more usable because of the AGC and as an introduction to both amateur radio and electronics construction gives a project that can be enjoyed for many years.

PARTS LIST

RESISTORS (0.25W metal film)

R1,5,7,20,30	47R
R2	1R0
R3,8	10R
R4,36,40	220R
R6	56R
R9,15,26,42,43	1k0
R10,27	100R
R11,24	15k
R12,29	2k2
R13,14,16,17,25,28,33,35,44	10k
R18,21,39	470R
R19	100k
R22,34,38	3k3
R23	18k
R31,37	750k
R32	22R
R41	220k
R45	6k8
RV1	5k ten turn pot
RV2	2k log ten turn pot with dial

CAPACITORS

C1,8,53	220n poly
C3	68n poly
CV1,2,3	30p TRIMCAP30G
C4,6,15,16,20,34,41	100µ elect
C5,7,9,13,17,32,38,39,51,56	100n ceram
C10	220µ elect
C11,14,29,33,35,36,44,54	10µ elect
C12,37,57,58	2µ2 elect
C2,19	Not fitted
C21,22	4n7 poly
C23,28,43	470p poly
C24,55	470n poly
C25	47n poly
C26,48,49	330n poly
C27	220p poly
C30,45	1n poly
C40,42	22µ elect
C47	47µ elect
C50	22p ceram
C52	12p ceram

SEMICONDUCTORS

Q1,6	2N4416
Q2	3N201
Q3	BC547
Q4	BF199
Q5	BB204
ZD1,2	9V1 400mW
D1	1N4148
IC1	TBA820M PowerAmp
IC2,3,5	LF351 Op-Amp
IC4	NE572 AGC IC

MISCELLANEOUS

Diecast Aluminium Box 190x110x60mm
pot knob
BNC socket & plug
Power socket & plug
Jack socket & plug
PCB standoffs 1/4 inch approx
Wire for connections
Components to make a 14MHz dipole antenna

INDUCTORS

L1,4	KANK3337 Toko
L2,3	47mH (181LY473J) Toko
L5	KANK3334 Toko

Anniversary AutoMate Mixer

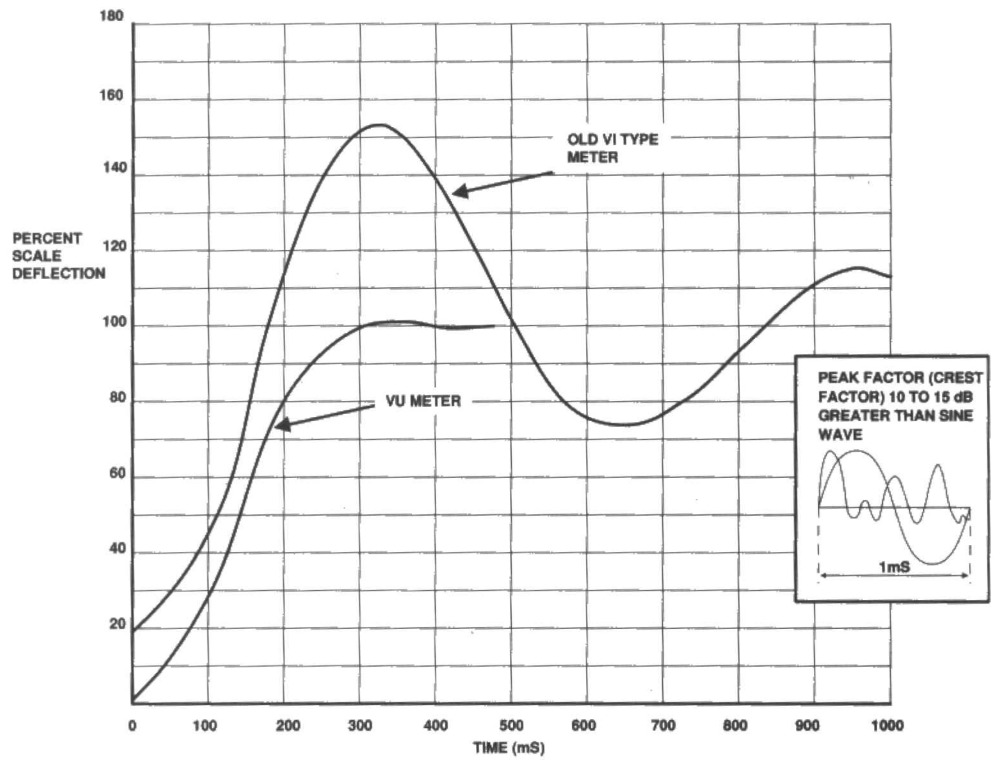


Fig.1 VU/VI meter ballistics

Does the step from little acorn to great oak involve a log amplifier? If not, why not? In preparation for next month's project, Mike Meechan explains.

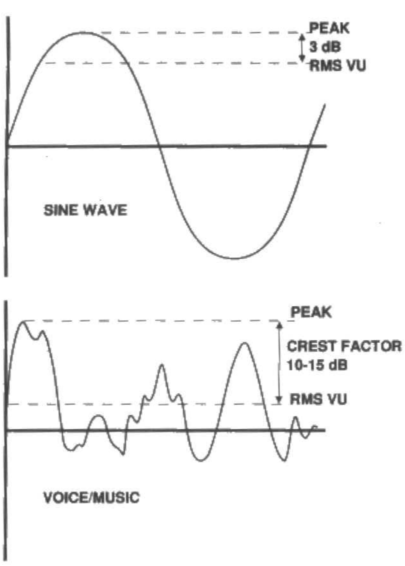


Fig.2 Comparison of crest factors with different types of programme material

The AutoMate series is almost one year old, and with this in mind, we've decided next month to give an 'Anniversary' present in the form of a front cover PCB for an LED Peak Programme Meter project, as fitted to some modules of the console. The topic of switching will thus be confined to the backburner until the May issue. As a prelude to the practical, constructional aspects of the meter which we'll present next month, we're presently going to look at why meters are important, what they do, and how the different types were evolved.

Meters - What Purpose do they Fulfil?

In any studio or broadcast environment, indication and control of the programme level leaving the desk is of paramount importance, since every recording and transmission medium has very definite, and indeed finite, headroom limitations.

In a recording studio environment, a maximum signal level in excess of this limit - overload - causes analogue tape recorders to saturate and distort, absoloute bedlam in a digital recording system where the 'all 1's' situation has

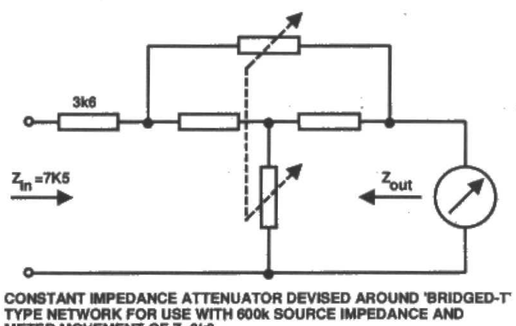


Fig.3 Constant impedance attenuator necessary when connecting VU meter to signals of non-standard level

been exceeded and the binary number system runs out of steam, PA amplifiers clip horribly causing the destruction of speaker cones, and record cutters produce grooves which run into one another. Any listener during the above scenarios, is, needless to say, mortally offended.

In a broadcast situation, the effects are even more far-reaching -the potential for widespread aural devastation is omnipresent. To elaborate, in an AM system, more than the sacrosanct 100% figure for modulation causes interfering splatter up and down the radio dial whilst with FM, over-deviation causes co-channel interference and plays havoc with discriminators in FM receivers. At the other end of the 'dial' so to speak, modulation levels less than 5% will cause an AM listener to turn up the volume on his/her receiver, thus increasing background noise. It is therefore the 'in-betweens', the dynamic range, which is important and must be monitored if it is to be controlled.

We have, of course, glossed over the fact that any broadcast establishment worth its salt will have more than one, single point of level control and quite possibly a whole chain of compressors and limiters, some of them quite brutal in action, such that neither the over-modulation nor the increased background noise situation can ever happen. Nevertheless, the scenario serves as a good example of the requirement for good metering.

Furthermore, monitoring video and audio becomes necessary if the balance leaving the studio is not to be altered by a transmitter site limiter or clipper, and there will also exist many pieces of equipment through which the signal must pass, and which also must not be overloaded.

Okay, so we've determined that metering in just about any audio system is a good idea. It might therefore be a good idea to look at different kinds of metering and the effects/ results that they produce.

Audio Metering - A Brief History

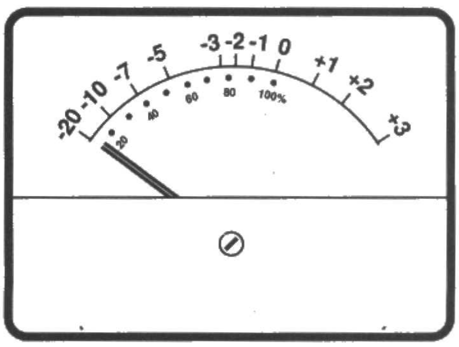
We're now ready to take an in-depth look at the metering used in professional audio systems. Any meter, for whatever purpose, is merely a measuring instrument. If our demand is for precise measurement, a precise measuring instrument must be used. And so it is with the instruments in a mixing console or any other type of audio apparatus purporting to be of a professional or semi-professional origin. The quality and precision of the meters are linked ultimately to both the use to which the particular apparatus will be put, and also to the cost of the unit.

In essence, there are only two types of meter - the W type and the Peak Programme type. Derivations and mutations of both types do exist but we'll NOT concern ourselves with those at this time. We'll look at the VU and the PPM in turn, starting with the meter. In this way, little convincing will be required of the necessity there was to develop another type of meter - the peak programme meter - to alleviate some of the problems associated with the VU type.

The VU Meter

The VU meter is actually a special form of the little-known VI (Volume Indication) meter and is used to measure the POWER levels of audio frequency signals. It is probably the most commonly encountered meter, being just about ubiquitous on many domestic cassette and tape decks, amplifiers and budget mixing consoles. These examples are not usually true VU meters, but rather horrid mutations of the original VU specification. That this is so probably accounts for the widespread, but somewhat erroneous, laymens' opinion that the moving coil VU meter is a pretty useless beastie when it comes to measuring audio levels.

A true VU meter is actually a very precise instrument. It gives completely credible results when used within the range of measurement for which it was originally designed. The meter movements - 200µA DC d'Arsonval types for the trivia-minded -have special ballistics. These ballistics average out complex waveforms to INDICATE properly programmme material which varies simultaneously in both amplitude and speech.



VU METER TO AMERICAN NATIONAL STANDARD C16.5-1954

Fig.4 VU meter Front panel

Again it is the Volume Unit truncation which may give the reader some idea of what its original use was. The development and specification for the meter was jointly undertaken by the Bell Telephone Laboratories, CBS and NBC, in the earlier part of this century. The involvement of Bell should give a further clue as to the original intended use for the instrument.

It was, in fact, to be used for measuring/indicating the level of signal on telephone lines. Coincident with the introduction of the VU meter to the telecommunications industry in 1939 was the standardisation of a new reference level of 1mW.

The W meter specification, believe it or not, is actually quite stringent and, it has to be said, rather long-winded in places -no references to the author, if you please! The salient points (taken from ANSI specification C16.5-1961) are as follows:-

Scale. There are two scales for the meter, one to be used

PROJECT

when the instrument is fitted to recording apparatus or test equipment and the other when it is to be used for broadcast monitoring purposes. The scale ranges from -20 to +3VU and also has a percent modulation scale ranging from 0 to 100%, the 100% position coinciding with the 0VU mark.

Dynamic characteristics. These provide a measure of the meter performance when it is subjected to both steady-state and transient input signals. When connected across a 600R line, the application of a short burst of 1kHz tone (which would cause a reading of 0W if applied continuously) should cause an overshoot of not less than 1% nor more than 1.5%. Further, at this level of tone, the meter ballistics are such that the needle should reach 99% of its deflection in 0.3s.

Frequency response. Basically flat to within 0.5dB up to 16kHz.

Impedance. This is an important one. When a 1kHz sine wave causing a deflection to OW is applied, the meter must present an overall bridging impedance of 7.5k to the 600R line across which it is connected. This includes the 3.6k series resistor.

Sensistivity. A sine wave of magnitude 1.228V RMS (4dB above lmW in a 600R line) should cause deflection to 0VU.

Although not mentioned as such in the specifications, brief reference was made in the opening paragraphs to the importance of ballistics. Ballistics encompass both the mechanical and electrical characteristics built into the meter movement, and certainly with moving coil types, - as opposed to bargraph types -the precision of the ballistics is related directly to the quality of the meter, and ultimately to the cost of it. (It is for this very reason that consumer equipment fitted, supposedly, with a VU meter has, in fact, no such thing but a very poor replica, with a cheap meter movement).

Conventionally, a given characteristic - in a moving coil meter -can be achieved by shaping the pole pieces or by counterweighting the pointer mechanism - parallel shunt resistances across the meter achieve the same effect at the expense of reduced sensitivity.

Figure 1 shows the ballistic response of the VU when compared with the older VI type. The graph shows the transient overshoot characteristics of both types when a 1s long 1kHz tone is applied. Note in particular the manner in which the VI meter continually overshoots while the VU comes to rest - settles - after 0.3s. This same overshooting effect is apparent to an even greater degree with a typical AC voltmeter.

So much for the specifications - what does it all mean to us as audio engineers? In essence, each of the various parts of the specification not only dictates how the meter should perform but just as importantly, in what aspects it cannot. To understand all of these, we'll look at each part of the specification in turn.

Where the VU meter Fails

Crest factor

No, nothing at all to do with surfing although it DOES have something to do with waves! A VU meter is true RMS meter, that is, it indicates the RMS value of a waveform, so long as the waveform is simple in nature. For such a waveform (a sinewave, say), the peak of the wave is only 2 or 3dB above the indicated value.

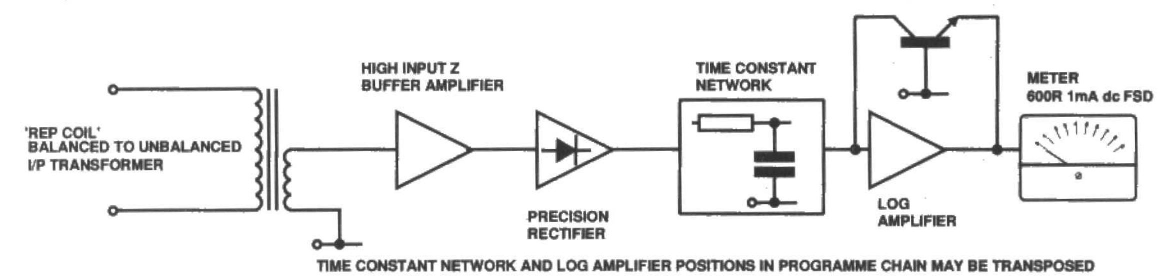


Fig.5 Block diagram of moving coil Peak Programme Meter

Complex waveforms such as those present with speech or music, however, may have a peak value some 12 to 16dB above the RMS value and the difference between the two is known as the CREST FACTOR this means peak value minus RMS value equals crest factor. The ballistics of the VU cause it to read somewhere between peak and RMS values in the instance such complex waveforms. Since typical programme material consists in the main of waveforms which are complex in nature, the VU can underread substantially on instantaneous peaks, 8 to 14dB being a not uncommon figure. This is mainly because it cannot follow small instantaneous peaks. In simple terms, the more IMPULSIVE the input signal, the greater the error between the displayed reading and the peak value. See Figure 2.

Different types of programme material have different crest factors - percussion instruments can have values up to 20dB, piano lies somewhere between 12 and 15dB and speech around the 8 to 10dB mark. To protect against these unseen overloads, a lead or safety margin is sometimes inserted into the circuit. This makes it more sensitive by an accurately prescribed margin (and can be varied depending on the type of material), so that the system is protected against transients up to a certain predetermined level. On a related note, the ballistics of the VU meter happen to correlate quite nicely with the level-integrating properties of the human ear. Because meter deflection is proportional to the energy of the wave, the VU is reckoned in some quarters to give an accurate indication of how loud, subjectively, different pieces of programme material are, in order to match them evenly. There do exist, however, methods of testing the VU to demonstrate that its ability to measure subjective loudness, can, in fact, cause inaccuracies in some instances. In fairness, it must be said that the PPM gives no indication whatsover, accurate or inaccurate, of the subjective loudness of the programme material - more of this, and the importance of it, later.

It is also important to note that the VU is in fact a POWER METER, intended to work with a specified impedance of 600R. Its use with any other impedance necessitates re-

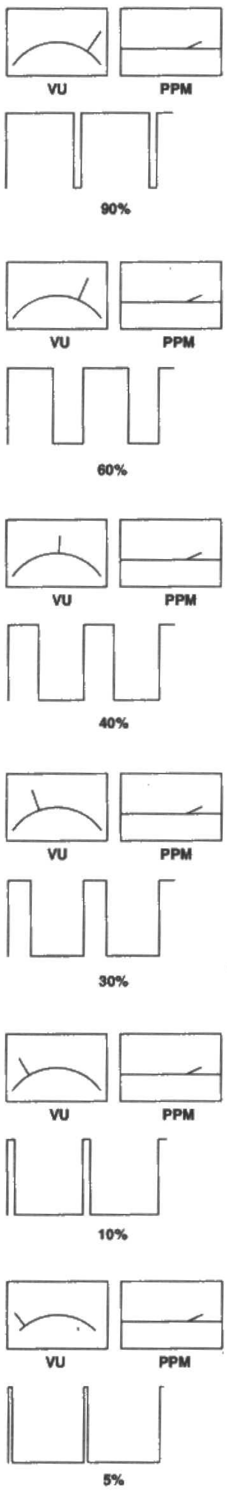


Fig.6 Diagram showing effect on VU and PPM types when peak amplitude is constnat but average value is decreased

calibration. Figure 3 shows a typical arrangement. Use with impedances other than the specified one has to be done carefully - an impedance of 3600R must always be presented to the meter movement (or meter ballistics will be affected), so that a constant impedance attenuator is necessary. Also, a correction factor must be added to the indicated reading when the meter is used with a non-standard impedance.

The VU meter is passive, comprising only of the meter movement, a bridge rectifier of selenium or copper oxide origin, and a resistor. This being the case, it must, of course, derive all of its power from the source being measured. As a rule, the power absorbed is small enough to be ignored, but at high powers, the drop in signal level because of the absorption of power by the meter circuit can become important.

The bridging action of the unbuffered meter circuitry also causes harmonic distortion in the signal being measured, distortion at a level high enough not to be ignored (0.3%) in any quality audio system.

Finally, the scale is a somewhat curious semi-logarithmic affair, cramped at one end and expanded at the other. This is so that each of the dB markings can be represented by whole numbers rather than fractions. Refer to Figure 4 - this type of scale can make it difficult to read accurately, as can the very short fall or decay time of the meter movement.

Improving on the VU

We should now be aware of the shortcomings of the VU meter. To improve upon it, any new type of meter must have the following features:-

1. Improved ballistic response so that transients and potentially damaging peaks can be detected fast enough to do something about them. It could then be used with consistent results with many different types of programme material. Decay time slow enough that the operator can read the peak values accurately.

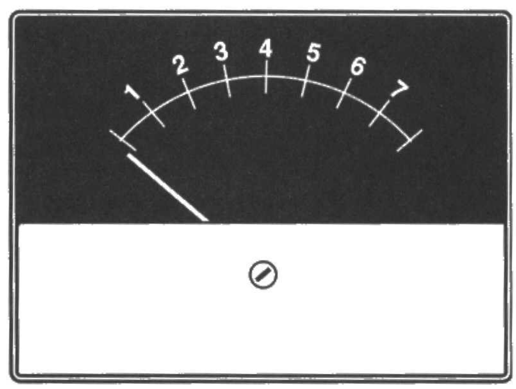
2. Active in nature so that it can be used both with lines of different impedances (without recalibaration) and different levels without causing any distortion to the programme material under test, that is, a voltmeter rather than a power meter.

3. Have a better scale - dB linear - so that accurate signal level measurements can be made over the entire scale range. Also, white on black rather than black on buff, as in the case of the VU. A simplified scale would improve 'readability'.

4. Deflection proprtional to the crest (peak), rather than the average of the waveform.

Peak Programme Meter (PPM)

This is the type of meter which was the BBC's answer to the problems encountered with the VU. Its use is universal, and indeed almost exclusive, within the broadcast industry and it has now been widely accepted throughout Europe. It is a very precise PROGRAMME measuring instrument, indicating accurately the peak voltage of the wave form of almost all programme material. Levels to within 0.5dB can be resolved on a normal BBC BS4297a PPM scale. I have qualified carefully the type of PPM because there do exist about two or three different internationally-recognised derivations throughout Europe and the States. These are the EBU, the Nordic N9 and the DIN 45 406 types. Essentially, they all do the same thing. Differences manifest themselves as minor changes to the meter ballistics, scale markings or full scale deflection, but type each follows an identical underlying philosophy of design and the points that separate each of the three types are indeed slight. It should be noted that VU meters are still used in broadcast establishments, but as an aid to line-up only, NOT as a programme measuring apparatus.



PEAK PROGRAMME METER TO BS5428a AND BBC ED1542

Fig.7 PPM front Panel

The PPM has five main elements, these being the meter itself, the input buffer amplifier, precision rectifier, time constant network and a log amplifier. See Figure 5.

Input Amplifier

This is a high impedance amplifier (nominally 20k) which ensures that the meter is buffered from the signal source which it is measuring. Proper broadcast types will also include a 'rep coil' or repeater coil. This is a 1:1 audio transformer which allows absolute isolation from the source

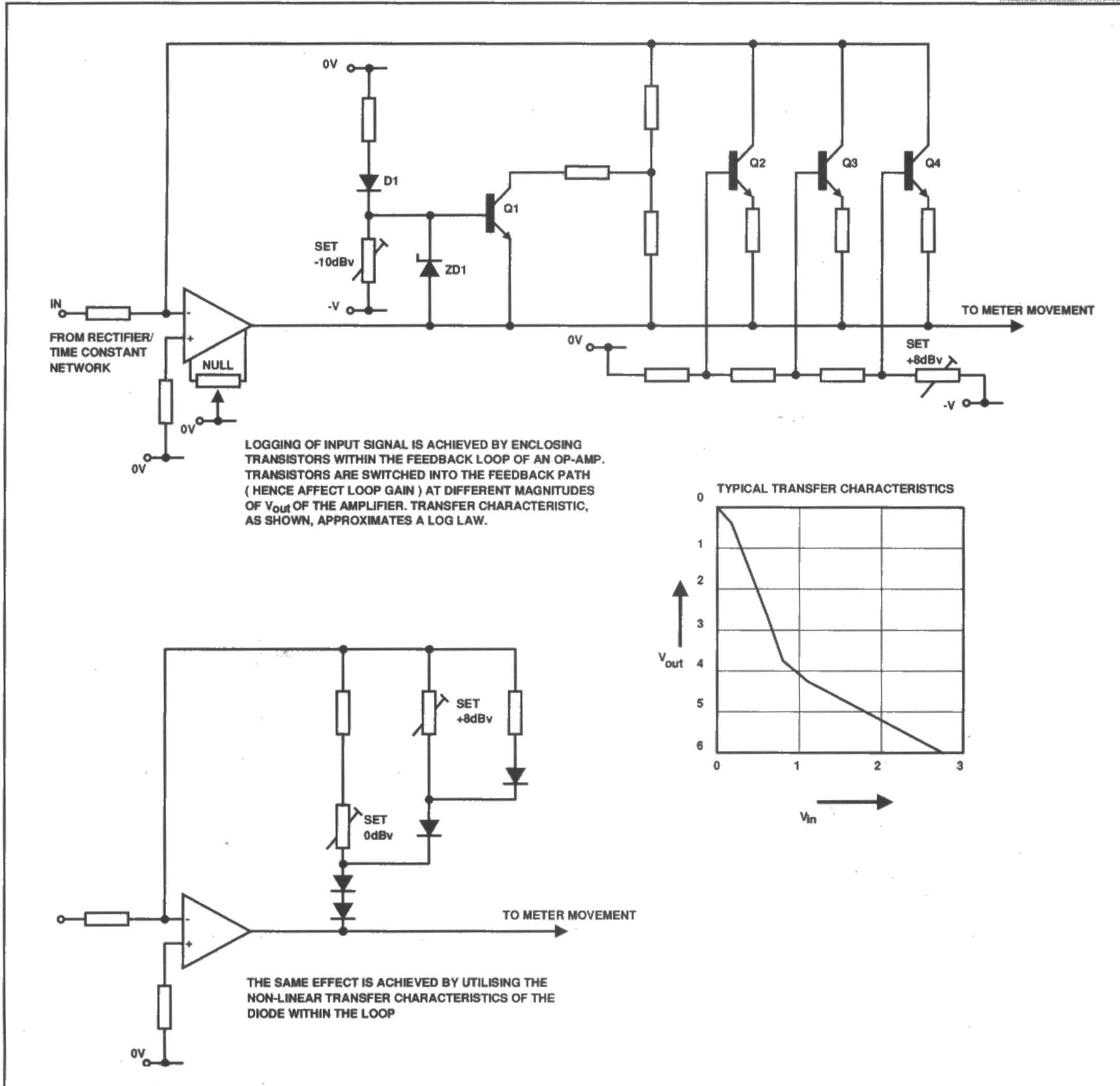


Fig.8 Methods of acheiving the logging response needed for the PPM

being measured. This satisfies requirement one for a meter which will not affect the circuit to which it is connected, nor will require recalibration when connected to a different impedance.

Rectifier

This is a precision rectifier which allows the meter to respond to both positive and negative peaks. It is active in nature and so gives proper, accurate results even with low level signals below the nominal 0.6V drop of a normal diode. This circuitry satisfies requirement 4.

Time Constant Network

The time constant network creates the necessary meter rise and fall times of 80ms and IS respectively (DIN 45 406 standard), 12ms and 2.85 (BBC ED 1542 / BS 4297a), and 5ms and 1.75 (Nordic N9). This satisfies requirement 2, which is for a meter with ballistics suited to the accurate reading of results by a human operator and 4, to a certain extent.

Rise time is not instantaneous as it is with some types of meters. Instead, there is a rigidly defined 'integration time' of 12ms. This integration time has been carefully chosen such that only those peaks which are audible - and which might cause an amplifier to clip or a transmitter to over-modulate - are indicated. The rise time-constant takes into account the accurately-defined mechanical characteristics of the meter such that the electrical -CR - time constant required is just 2.5ms.

In this way, short-duration transients which are otherwise inaudible to the human hearing system, and harmless to any electronic reproducing or amplification apparatus connected

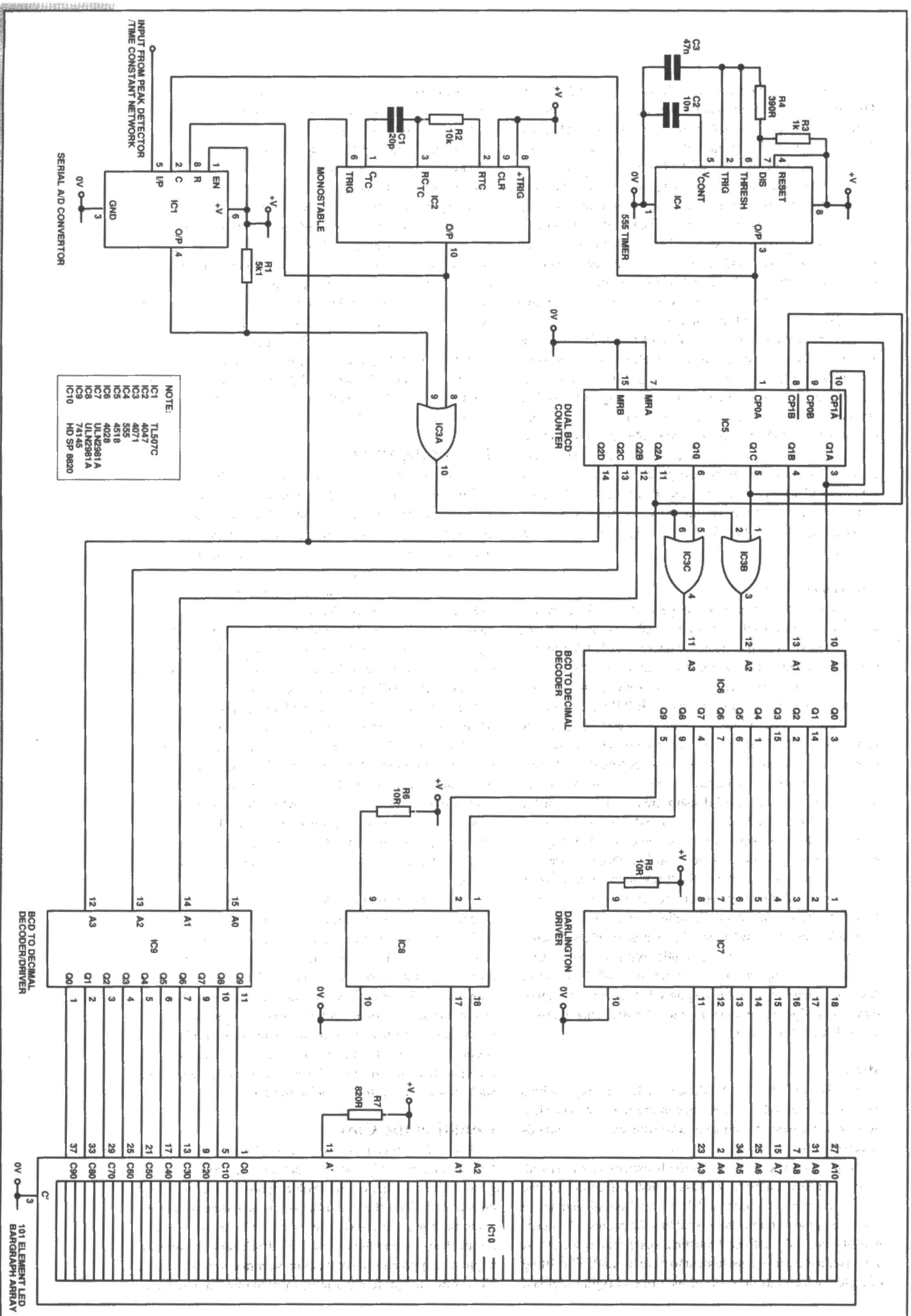


Fig.9 Professional audio application for LED bargraph display

to the system, are allowed to pass through without detection. This alleviates the need, when using many types of meters, to allow the meter to go 'into the red' when recording because the meter over-reads (because of a very fast attack time) or - as is the case with the VU - of deliberately under-recording because the apparatus cannot adequately detect fast and potentially damaging transients. The integrating time constant has been chosen after many years of experience - intuitively, we may have wished for a shorter time constant which would have yielded more accuarte peak readings. Unfortuntely, this would have made modulation levels unreasonably low - the compromise value, with one or two misgivings, works well in practise.

An excellent demonstration of the PPM's ability to follow accurately the peaks of any input waveform is shown in the following example. A square wave of specific peak-to-peak value is inputted to the PPM. The mark:space ratio is then altered, from a long mark/short space to short mark/long space. Although the average or RMS value of the waveform changes dramatically, from one extreme of the Mark:Space control setting to the other, the peak value has remained constant and the meter reading should indicate as such. A VU meter, on the other hand, would show a steadily decreasing reading as it followed faithfully the average of the waveform. See Figure 6.

Log Amplifier

This is, as the description suggests, an amplifier with a log gain response so that the meter scale, whilst displaying dB's, can have a linear - and hence operationally friendly and readable - front panel scale. See Figure 6. The scale is annotated from 1 to 7 (BS 4297a) or from -12 to +12 (BS 4297b). The scale partition is 4dB, with PPM 1 equating to -12dBU, PPM 2 to -8dBU, etc. Careful investigation of the scale would reveal that not all of the markings are equidistantly-spaced, with the greatest error apparent at the extremes of the scale. See Figure 7. This is necessary because the logging amplifier used doesn't create a true log of the input signal magnitude, but a very close approximation, as shown in Figure 8. This part of the meter satisfies requirement 2. Active non-linear devices (such as diodes or transistors) are enclosed within the feedback loop of an op-amp circuit. Each of the devices enclosed within this loop has a different turn-on threshold. It follows, therefore, that the feedback resistance, and hence the loop gain, alters depending upon the output signal magnitude. With suitable resistor values determining the turn-on thresholds of these active devices, a quasi-logarithmic response for the network can be synthesised. Figure 8 shows a typical transfer characteristic for such a configuration.

Meter

This is a DC 600R lmA full scale deflection type, with a meter scale marked in accordance to the relevant specification, and ballistics tested and approved by the standards governing body.

Proper VU meters can be relatively expensive whilst with PPM's, this is even more so. This probably accounts for the extensive fitting of mutated 'VU meters' on all manner of audio equipment. It must to be said that the proper VU meter, with its carefully defined ballistics, scale markings, etc. is very useful measuring instrument to have to hand. The fitting of meters which fall far short of the original rigidly-defined specification has, as we mentioned earlier, sullied the reputation of the VU to a certain extent. In the proper element, and employed correctly, a good VU meter is a most useful instrument. Some professional examples include a 'peak' LED which lights on transients, thus alleviating, to a certain extent, some of the previously-documented problems.

In many ways, this is an ideal combination of two differing approaches to the problem of accurate monitoring. Something similar has happened with the PPM. Many modern cassette decks feature LED or flourescent-type bargraph displays. Of these, the majority purport to being 'peak programme meters', if the front panel labelling is to be believed. My own cassette deck at home, a semi-professional machine coming from the stable of a highly respected hi-fi manufacturer of Oriental origin, includes just such a device. The displays are solid state and therefore inertia-less. They are therfore PEAK READING meters rather than true peak programme meters.

Uses of the PPM

In a broadcast studio environment, the PPM fulfils several important functions. At the transmitter, the stereo transmission is coded into M and S form - Mono and Side, or Sum and Difference - before being modulated on to the RF carrier. Mono transmissions, ie, long, medium and short wave require only the M signal.

There is a requirement in the studio, therefore, to monitor FOUR different signals. This is to ensure that none of these signals can cause overmodulation. These are A, B, M and S signals - Left and Right become A and B in a broadcasting environment. Normally, the stereo A and B signal is covered on a dual needle PPM, with a green needle indicating the A or left (port) side and a red one the B or right (starboard) side. M and S indication uses a similar arrangement, with the needles coloured white and yellow, respectively, in this instance. Important characteristics of the signal are yielded at a glance. The A and B stereo legs normally will show approximately the same reading while the S signal will be 4 - 8dB less than the M. An S reading higher than the M one indicates phase-reversal, and if S is zero, the signal must originate from a mono source, or have a very narrow stereo image.

The engineer must check continually that the rogramme balance is 'mono-compatible', as many radio listeners will, perhaps, be using portable receivers capable only of mono reproduction. This is particularly important in drama or orchestral productions where much of the 'action' may be happening off-centre. The programme may sound fine in stereo, but if the mono mix isn't constantly monitored, and the balance adjusted accordingly, some peculiar effects can become apparent to the mono listener. PPM's are also incorporated into various audio measurement test apparatus, such as level, distortion or noise meters.

Counting the Cost

The PPM is much more expensive than a similar quality VU because not only does the meter movement have to be good with an accurate, predictable ballistic response - as it does with the VU - there are also precision outboard electronics to be fitted and considered (and a PSU to power everything). The cost and the fact that all PPM's require precision alignment apparatus to set them up accurately mean that the VU is often the preferred arrangement in many applications,

since it needs only one adjustment and no off-board electronics or power supply.

Recent innovations and developments in indicator device technology - gas discharge, LCD and plasma displays - have brought the cost of these down to cost levels make them a viable financial proposition for use in commercial products. Since they are, in essence, digital in nature, these devices lend themselves readily to control by microprocessors and associated electronics. This means that many facilities which could never be made available on an analogue, moving coil-style meter present themselves as possible options.

These options include the possibility of direct interfacing with digital audio bitstreams (with no A/D, D/A conversions necessary), peak hold and various other memorising functions, control of display brightness in response to ambient light conditions, etc. Figure 9 shows a typical arrangement for control of the Hewlett-Packard 101 element light bar. This type of display is now finding its way into many professional digital audio applications such as CD or DAT mastering suites. Some can interface directly to the recording equipment (Sony PCM 3324 or PCM 3328 multitrack recorders) via the AES/EBU or SDIF (RS 422) data protocols. Attack time for these types is specified as being so many sample periods in length. Perhaps, this is the metering of the future.

In the example shown, the analogue input voltage is applied to a TL057 A/D convertor which has seven bit resolution. The digital output of this is in serial form and is a pulse-width-modulated waveform of width corrresponding to magnitude of the analogue input voltage.

The 4518 is a dual BCD counter configured as a 0 to 99 counter with the 'A' outputs corresponding to the 'units' and the 'B' outputs to the 'tens'. The 'one' outputs are decoded by the 4028 BCD-to-decimal decoder and used to drive the ULN2981A driver IC. This is used to source the anodes of the bargraph array with 80mA peak/segment. The 'tens' outputs from the 4518 drive the group cathodes through a 74145 BCD decoder/driver. The circuit multiplexes through 100 to 91, then 90 to 81 and so on and so forth. During the time that the output from the A/D is low, the corresponding display elements will be illuminated. The A/D output is reset each time the 4518 resets whilst a high output from the A/D disables the display by forcing the 4028 input pins into an invalid state.

Next month, for all of you itching to use a soldering iron in this project, we present on the front cover a PCB with which you can build a true studio-standard LED Peak Programme Meter.

References

Audio Cyclopedia (edited by Glen M. Ballou) - VI Meters and Devices (Glen M. Ballou) Howard W. Sams

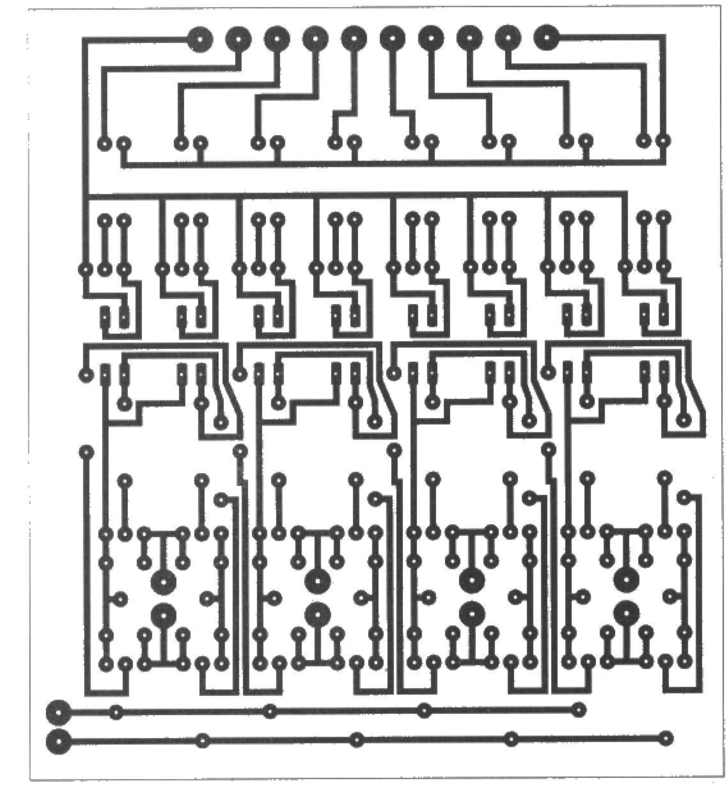
Sound Recording Practise (edited by John Borvork) - Radio Broadcasting (Dave Fisher) Oxford University Press

Hewlett Packard Optoelectronics Catalogue - Application Note 1007

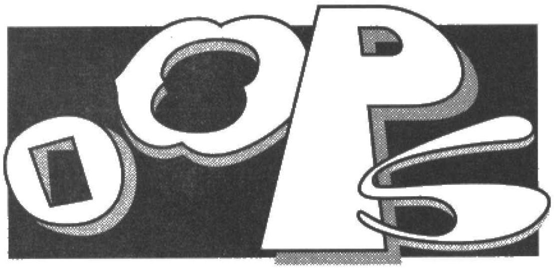
NEXT MONTH - PART 2 USES THE COVER PCB TO CONSTRUCT THE PPM

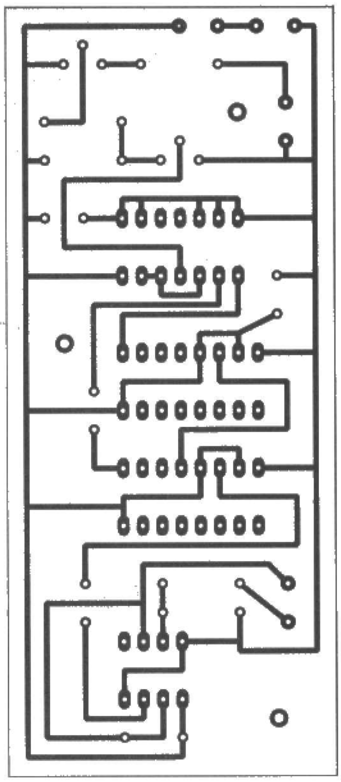
PCB Foils

The PCB foil patterns presented here are intended as a guide only. They can be used as a template when using tape and transfer for the creation of a foil.

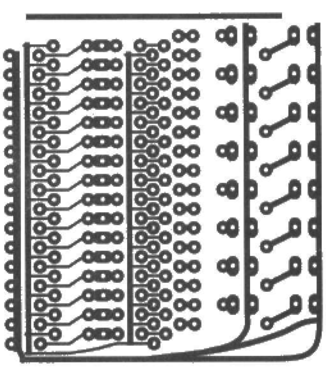


Disco Amiga (Motor Control Board)

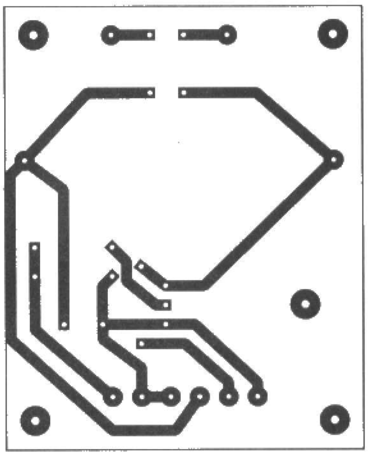




LED Stroboscope



IC Tester



Ni-Cd Battery Charger

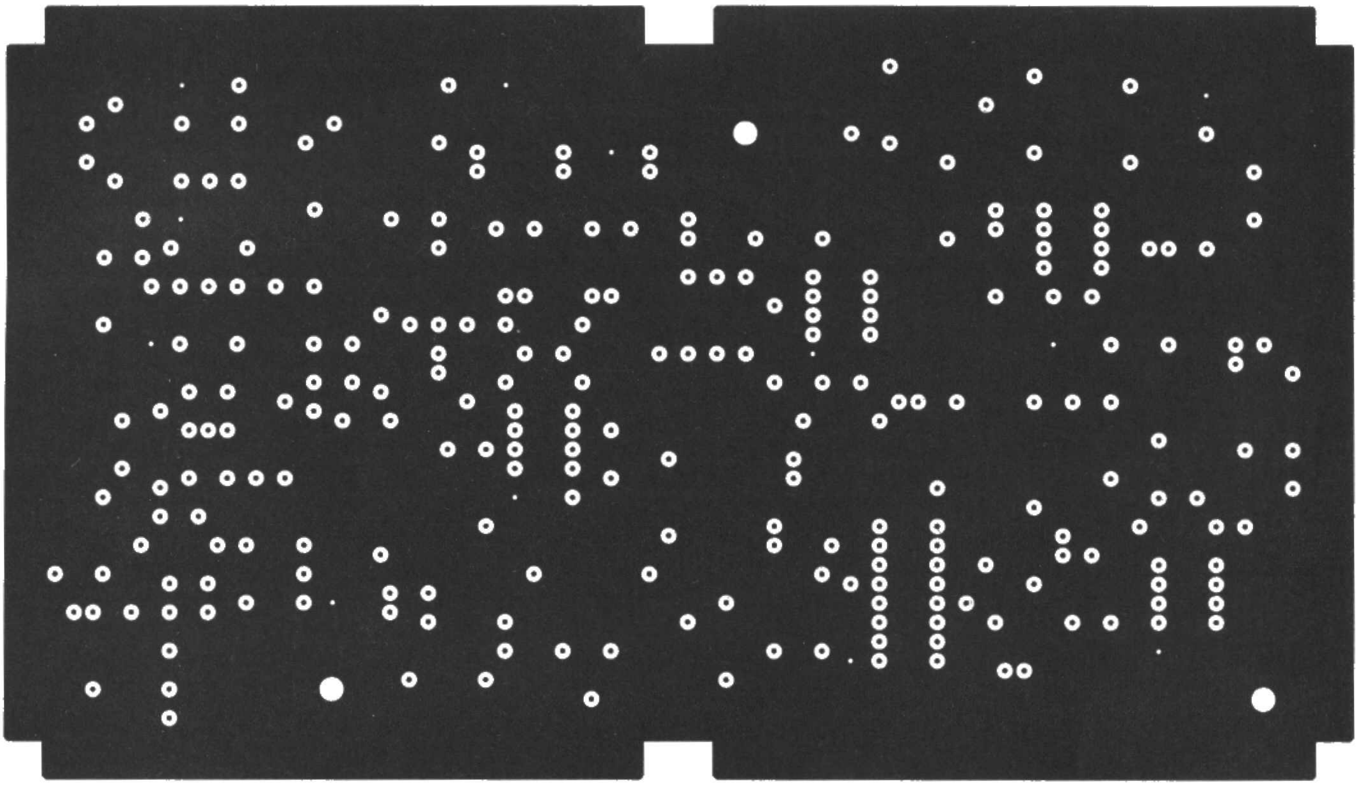
EPROM Programmer Jan/Feb '93

Fig.1 Section of IC4 with pins 1&2 should be IC4a and IC4a should be labelled IC4c. Fig.2 PROG PULSE signal from IC15c pin 8 should be PROG PULSE-. RN1 common pin should be shown connected to V+. IC9 outputs on pins 16 and 1 should be R/W- and R-/W respectively. Fig.3a R/W signal into D2 should be R-/W.

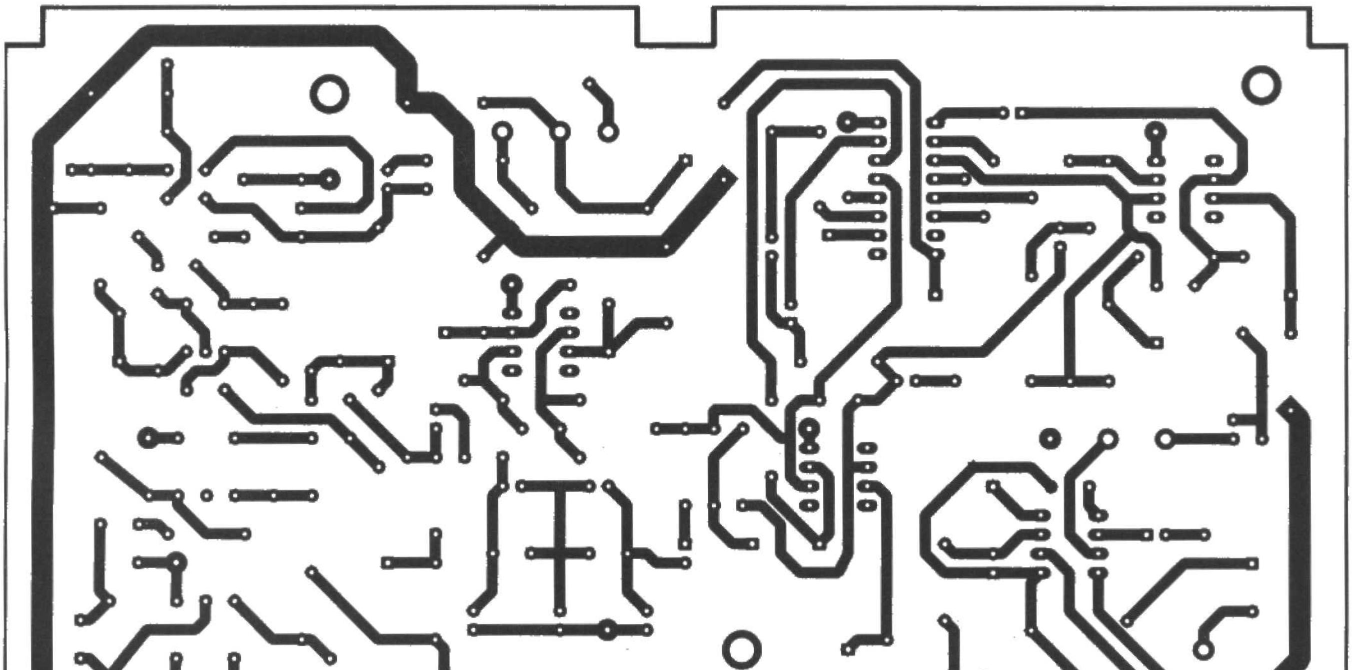
Fig.4 C12 has been omitted. It should be in the line from IC19 pin 6 and the junction of Q11,Q12 and Q15, to GND (drawn between Q14 and Q16). As drawn the output from IC19 is shorted to GND.

Remote controlled receiver Jan '93/Transmitter Feb '93

Delete C1a. For C1 use a 470n AC 250/500 XY Capacitor (Maplin UL61R). Remove the three pin connecting block and insert a two pin connecting block for 250V AC live and neutral. Replace the 1A fuse with a 250mA type. For XT the ceramic oscillator, there is a choice of matching pairs either 500kHz or 455kHz (455kHz Maplin UL61R). C6 should be 100n and C5 should be 470n. In the transmitter overlay (Fig.2) R4 (750k) and R5 need to be transposed and positive of C1 is to the left In Fig.1 R1,2,3 should be 1R as parts list IC1 pin 18,C1,C2 and C3 should be connected to earth (dot join missing). An isolating power supply transformer was tried in a proto-type instead of the mains capacitor but gave unsatisfactory results. This was probably due to RF interference with the transformer in close proximity to to the IR detector.



Direct Conversion Receiver (Component side)



Direct Conversion Receiver (solder side)

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E9303-1	**Ni-Cd Battery Charger**	**E**
E9303-2	**IC Tester**	**E**
E9303-3	**Disco Amiga (Motor Driver Board)**	**H**
E9303-4	**Direct Conversion Receiver (Double Sided)**	**N**
E9303-FC	**LED Stroboscope**	**F**
E9302-1	**EPROM Programmer (Double Sided)**	**N**
E9302-2	**Sound to MIDI Board**	**L**

PCBs for the remaining projects are available from the companies listed in Buylines.
Use the form or a photocopy for your order. Please fill out all parts of the form. Make sure you use the board reference numbers. This not only identifies the board but also tells you when the project was published. The first two numbers are the year, the next two are the month.
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E9111-4	Nightfighter- Display Board (2 sided)	M
E9111-5	Nightfighter - Bass Beat Trigger (2 sided)	L
E9111-6	Nightfighter- Sequence Select (2 sided)	H
E9111-7	Nightfighter - Master Controller PSU	K
E9111-8	Nightfighter- Output Switch (2 sided)	M
E9112-1	Nightfighter Sensor Switch Master Control (2 sided)	L
E9112-2	Nightfighter Sensor Switch Channel Control (2 sided)	L
E9112-3	Nightfighter Sensor Switch Sound Trigger	H
E9112-4	Nightfighter Connector Board	F
E9112-5	Nightfighter Sensor Switch PSU	K
E9112-6	Nightfighter 8-Channel Input Interface (2 sided)	P
E9112-7	Power On and Overload Regulator	P
E9201-1	Laboratory Power Supply	F
E9201-2	Test Card Generator Board	M
E9201-3	LED Star (2 sided)	L
E9201-4	Enlarger Timer Main PCB (2 sided)	N
E9201 -5	Enlarger Timer Selector Board (2 sided)	K
E9201-6	Enlarger Timer Switch PCB	E
E9203-1	MIDI Switcher- Main Board	L
E9203-2	MIDI Switcher- Power Suply	E
E9203-3	Sine Wave Generator (surface mount)	F
E9204-1	Auto Car Lights	F
E9205-1	Bat Detector	E
E9205-2	Pond Controller	F
E9206-FC	Stereo amplifier	G
E9206-2	Xenon flash trigger Main Board	J
E9206-3	Xenon flash trigger Flash Board	F
E9206-4	Scanner for audio generator	D
E9207-1	Improved Rear Bike Lamp	D
E9207-2	Mini Baby Bug Monitor	C
E9207-3	Ultrasonic Audio Sender (2 boards)	H
E9207-4	Camera Add-on unit (4 boards)	O
E9207-5	AutoMate 5V/48V Mixer power supply	J
E9207-6	AutoMate Precision 17V power supply	J
E9207-FC	Surround Sound Decoder	F
E9208-1	Dynamic Noise Limiter	F
E9208-2	Touch Controlled Intercom (2 boards)	H
E9208-3	MIDI Keyboard	K
E9208-FC	Battery charger	F
E9209-1	Intercom for light aircraft	H
E9209-2	Alarm protector	C
E9209-3	Temperature controller	M
E9209-FC	45W Hybrid power amp	F
E9210-1	Universal I/O Interface for PC (2 Sided)	N
E2910-2	Rapid Fuse Checker	E
E9210-3	Heartbeat/Audio Listener	E
E9210-FC	Wizards Hat	E
E9211-1	Electronic Die	E
E9211-FC	Car Alarm	F
E9212-1	Digital Circuit Tester	F
E9212-2	Communications Link by RS232	L
E9212-FC	Mains Inverter	E
E9301-2	Fading Festoonery	G
E9301-FC	Infra Red Receiver	F
E9302-FC	Infra Red Transmitter	E
E9302-3	Puddle Tec	E

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